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THE PLANT DISEASE REPORTER

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THE PLANT DISEASE SURVEY

Division of Mycology and Disease Survey

BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Division of Mycology and Disease Survey serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

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THE PLANT DISEASE SURVEY
DIVISION OF MYCOLOGY AND DISEASE SURVEY

Plant Industry Station — Beltsville, Maryland
Volume 36 — July 15, 1952 — Number 7

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AN IMPROVED SYSTEM OF MUSHROOM CULTURE FOR BETTER CONTROL OF DISEASES

E. B. Lambert and T. T. Ayers

For many years growers have recognized that the usual system of pasteurizing mushroom beds is frequently ineffective in eliminating harmful fungi, insects and nematodes from the beds. This is due to insufficient heat in the lower beds or to cold spots in the beds caused by over-composted wet manure that cannot produce sufficient heat.

Since 1949 a system of composting and "pasteurizing," developed to assure sufficiently high temperatures in the beds to eradicate most pests has been tested in our experimental rooms. The necessary heat is obtained by raising the air temperature in the house to 150°F. and then reducing it to 105° after a few hours and maintaining this temperature for several days to recondition the compost in accordance with the principles discovered in earlier experiments (1). The yields obtained in the first experiments were sufficiently promising to warrant further tests and up to the present time four experimental crops have been harvested using the new "two-phase pasteurizing" system as a basic procedure (2).

Several phases of the cultural procedure have been investigated to determine the optimum conditions for high yields. Some of the factors tested are supplemented vs. non-supplemented compost, temperature and duration of the secondary pasteurization, moisture of the compost, and depth of bed. So far, the system has given very satisfactory results and tests in commercial houses have shown that the pasteurizing conditions are easily duplicated when the houses are equipped with auxiliary live steam. A brief summary follows of the procedure that, in our judgement, has proved the most satisfactory. Certain of the experimental results leading up to the development of this procedure are also included.

Plot Technique for Yield Tests. The yield tests were made in trays having a surface area of 3.5 square feet with 12 experimental treatments in each replicate block (Fig. 1). The experiments were arranged in six randomized blocks. Sufficient compost to fill all the trays in each block was removed from the main heap and mixed thoroughly before filling to insure that the compost in every tray was as nearly alike as feasible except for the factor being tested. The recorded yields are the weights of pulled mushrooms less 20 percent to account for the stubs that are normally trimmed off. Statistical analyses indicated that the least significant difference, at the 5 percent level, between the mean yields of six replicates was usually less than 10 percent. Except in Table 1, where individual yields are given, all the recorded yields are the averages from six replicate trays, each harvested at least 25 times. The yields for the four crops were very consistent. The seemingly low yields in Table 2 and Figure 5 are due to the shallow fills and shorter harvesting periods.

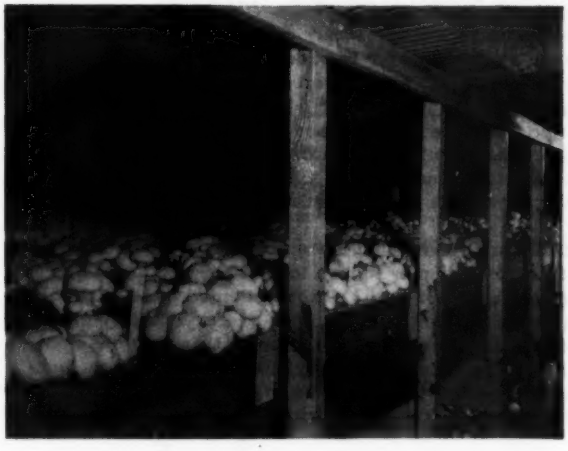

FIGURE 1. First break of mushrooms in experimental growing room at Beltsville, Md.

Outdoor Composting. A medium-strawy horse-manure supplemented with 150 pounds of dry poultry litter (1.5 percent nitrogen) and 30 pounds of gypsum per ton of manure was used for most of our experimental crops. The objectives of the outdoor mixing and composting are to distribute the supplements uniformly throughout the compost, to moisten the manure sufficiently, and to pass the compost through the initial explosive stage of fermentation. Another objective is, at the same time, to retain sufficient heat-generating capacity in the compost to insure against cold areas in the beds during pasteurization. Because indoor pasteurization is considered to be the critical part of the fermentation procedure, the outdoor composting is done as economically as possible with no regard for control of the aeration of specific areas in the pile.

Table 1. Yields of mushrooms in pounds per square foot from trays filled to different depths.

Plot	A	B	C	D
1	6.33	5.19	4.60	4.04
2	6.22	4.97	4.32	3.97
3	5.79	5.56	4.27	3.70
4	6.16	4.77	4.28	3.70
5	5.71	5.26	4.48	3.67
6	5.79	4.52	4.16	3.78
Average	6.00	5.02	4.36	3.81

Note: The trays were filled at the following rates per ton of fresh manure: Those in column "A," 73 square feet per ton; "B" 97 square feet; "C," 120 square feet; "D," 146 square feet; ratios on a dry weight basis are shown in Figure 2.

Table 2. Effect of different temperatures of reconditioning on yields of mushrooms.

Manure-temperature °F.	Pounds per square foot in 65 days
135°	2.6
125°	3.3
115°	3.6

Note: The beds were filled at the rate of 146 square feet per ton of fresh manure.

The manure is assembled in elongated, wedge-shaped ricks about 8 feet high, 12 feet wide, and 20 feet or more in length. The turnings are made with a standard composting machine so that the original shape of the rick is again approximated after each turning. During each turning the manure is scattered into the new pile at random, with no systematic attempt being made to change the location of manure from the inside to the outside of the heap. The entire outdoor composting procedure is accomplished with three turnings and is usually completed in about 15 days after the first turning. During the first turning as much water is added as the manure will hold. During the second turning the supplements are added, and also water if it is needed. The third turning is made about five days before the beds or trays are to be filled, and sufficient water is added so that the moisture content of the compost will be about 70 percent at filling time.

The 15-day period of outdoor composting appears to be the minimum time required for proper mixing, watering, and breakdown. A longer period is undesirable since the remainder of the fermentation process can be carried out to better advantage indoors under controlled conditions.

Depth of Fill and Type of Packing. Satisfactory yields have been obtained with all depths of fill tested, from 4.6 pounds to 9.1 pounds of dry matter per square foot of bed space. The relation of bed fill to yields is shown in Table 1 and Figures 2 and 7. There seemed to be little difference between yields in beds filled loosely and beds packed (Fig. 3). We prefer a lightly packed bed. The thicker beds are somewhat less efficient in the use of the manure than thin ones but yield more per square foot of bed space. The comparative efficiency of deep and shallow bed fills is also affected by the length of the cropping period. The curves in Figure 7 will enable a grower to select the best thickness of bed and length of cropping period to suit his particular circumstances.

"Pasteurizing." The pasteurizing was conducted in two phases. The first phase, at high temperature for a short time, eliminates injurious fungi, nematodes, and insects. The second phase, a comparatively low-temperature fermentation for a longer time, reconditions the compost so that it is suitable for subsequent growth of the mushroom mycelium but unsuitable for growth of the Chaetomium "weed mold." A schematic diagram is given in Figure 4 to compare the temperatures attained by air and compost in the two-phase pasteurizing system with those attained in the usual pasteurizing procedure.

After filling, the beds are allowed to heat naturally overnight and then steam is turned into the room to raise the temperature of the air surrounding the beds to approximately 150°F., with the temperature of the compost 5° to 15° higher. This "peak heat" is held for about six hours. Then the steam is shut off and the bed temperature is lowered rapidly to approximately 115°, with a minimum air temperature of approximately 105°. The rooms are held at this temperature from 5 to 7 days by using steam when necessary. Ammonification usually ceases in 3 or 4 days, but

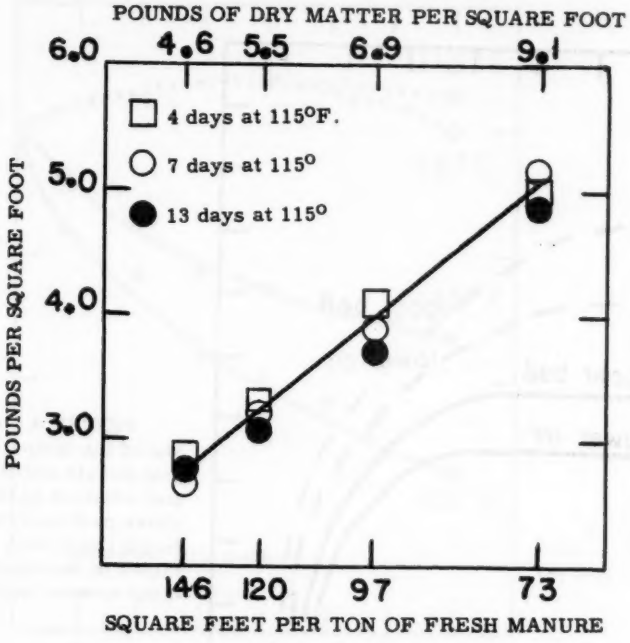

FIGURE 2. Relation of yield of mushrooms to depth of fill and duration of reconditioning period.

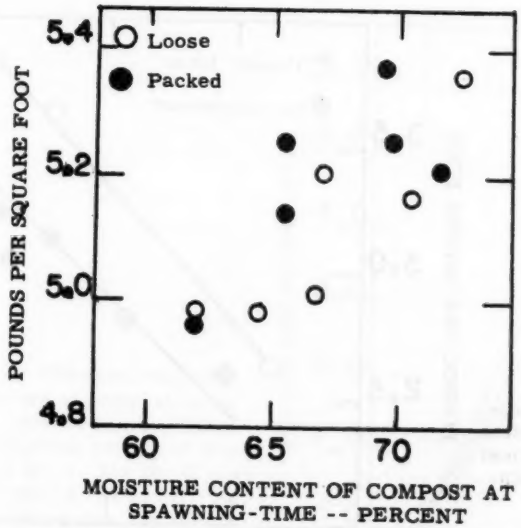

FIGURE 3. Effect of moisture content and packing on yield. (The beds were filled at the rate of 95 square feet per ton of fresh manure; 90-day picking period.)

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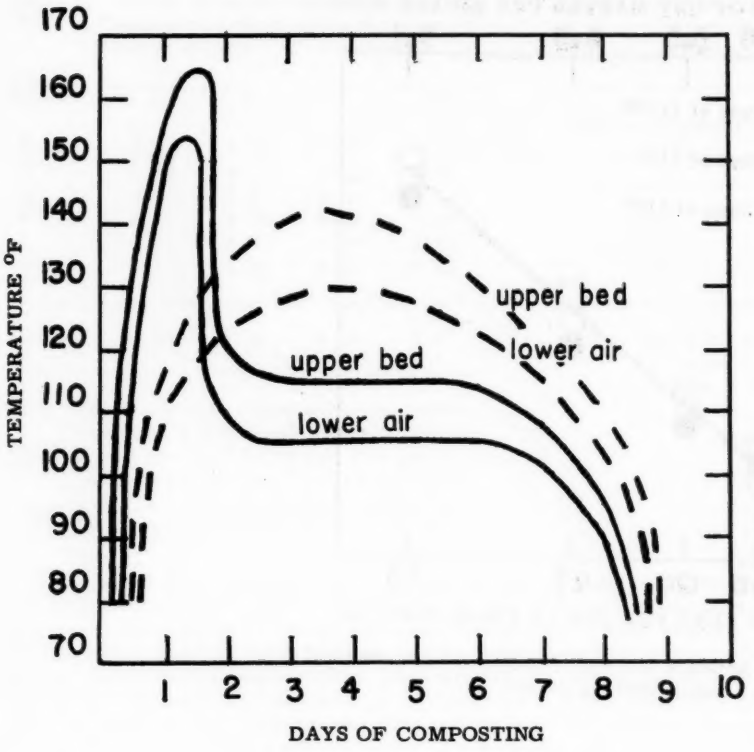

FIGURE 4. Comparison of the temperatures that the air and the compost attained in the two-phase pasteurizing system (solid lines) with those attained in the usual pasteurizing system (broken line).

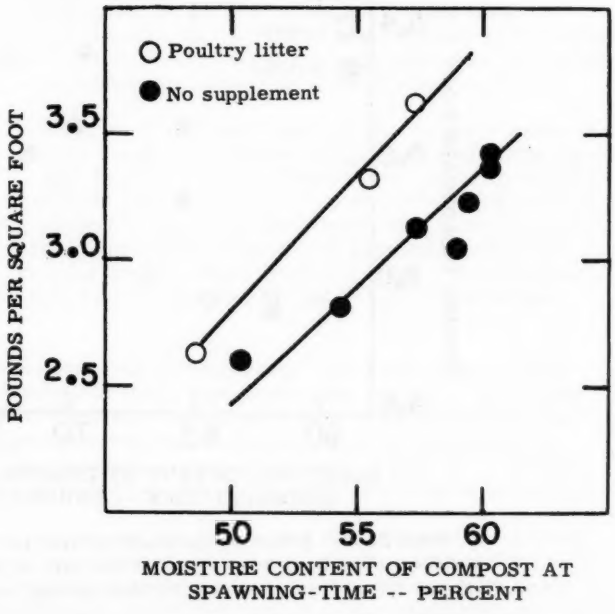

FIGURE 5. Effect of moisture content of compost and poultry litter supplement on yield (146 square feet of bed space per ton of manure; 80-day picking period).

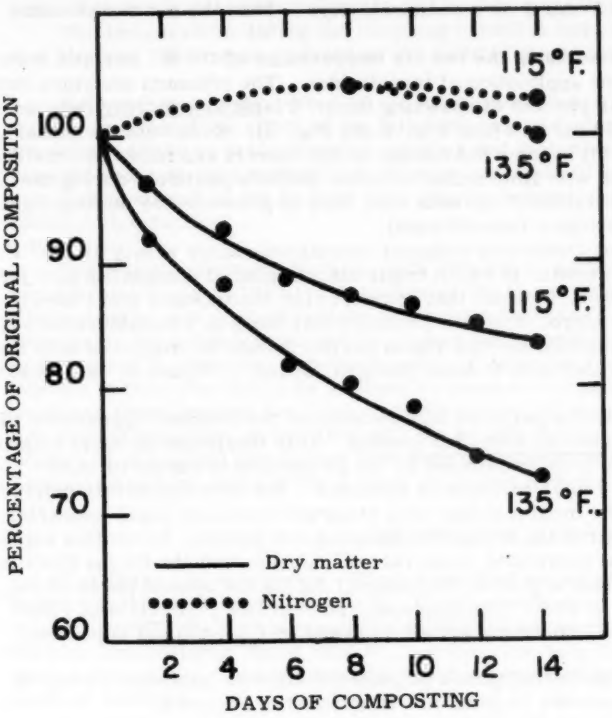

FIGURE 6. Effect of temperature on the decomposition of dry matter and loss of nitrogen in compost.

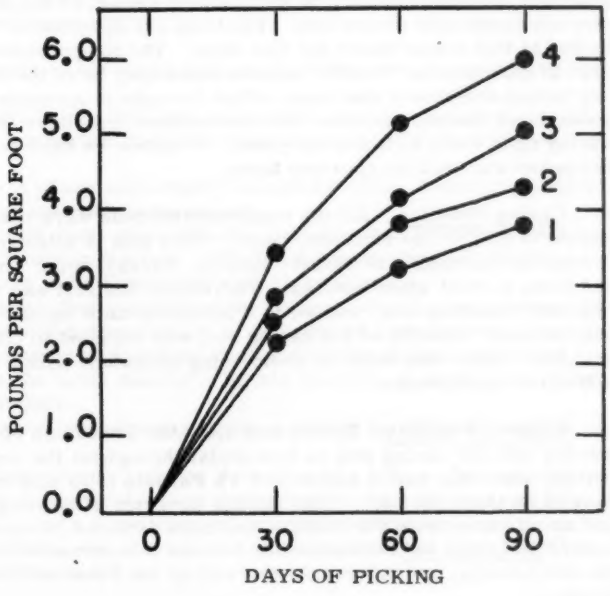

FIGURE 7. Effect of cropping period and amount of compost in the bed on yield. (The beds were filled at the following rates per ton of fresh manure: Curve No. 1, 146 sq. ft.; No. 2, 120 sq. ft.; No. 3, 97 sq. ft.; No. 4, 73 sq. ft.; ratios on a dry weight basis are shown in Fig. 2).

the air temperature is maintained at 105° for 2 or 3 additional days. Then the bed temperature is lowered rapidly to 75°.

During the second phase of the pasteurizing the low air temperature of 105°F. permits free access to the rooms for watering and the application of insecticides. The optimum moisture content of the compost is between 62 and 68 percent at spawning time. Yields are sharply reduced when the moisture content falls below 60 percent (see Fig. 5 and Fig. 3). Even with the initial air temperature of 150° the floor may not become hot enough to kill insects and mites in crevices. Therefore, the floors should be sprayed with lime sulfur or other suitable pesticide during the second phase of pasteurization. Reinfestation of the beds with flies is prevented by dusting lightly with 1% Lindane (gamma isomer of benzene hexachloride).

Earlier experiments (1) showed that mushroom compost decomposes more slowly at 170° F., than at 135°. Similar incubation experiments, in which triplicate samples of compost in pint jars were subjected to controlled temperatures, indicate that compost also decomposes more slowly at 115° than at 135° (see Fig. 6). Therefore, it seems probable that there is a considerable saving in nutrient materials in the bed throughout the two-phase pasteurization as compared with the usual pasteurizing process. The slight increase in total nitrogen, shown in Figure 6, is probably due to sampling error.

An unusual characteristic of the low-temperature fermentation is the frequent appearance of "heat mold" throughout the bed after ammonification has ceased. This thermophylic mold appears to be beneficial rather than harmful. It is characterized by the production of chains of thick-walled, brown, spherical spores about 9 to 16 microns in diameter. We have tentatively referred this fungus to the genus Torula. It is the mold that has been observed for many years appearing over the surface of mushroom beds towards the end of the sweating-out period. Incubation experiments with compost in quart jars held at controlled temperatures indicate that the fungus flora in the beds will be favored by different temperatures in the compost during the second phase of the pasteurizing period as follows: 95° F. to 100°, Coprinus spp.; 105° to 120°, Torula spp.; 125° to 140°, Actinomyces spp.; 150° or over, no fungus growth followed by Chaetomium spp. when the beds are cooled.

The effects of temperature during the second phase of pasteurization on subsequent yield of mushrooms and of the duration of this process on yield are illustrated in Figure 2.

Spawning and Spawn Growth. Grain spawn is broadcast at the rate of one bottle to 60 square feet and allowed to grow about two weeks before the beds are cased. At the time of spawning the hydrogen ion concentration of the compost should be below pH 8.2 and the average moisture content approximately 65 percent. The beds are spawned at 70° to 75° F., and the spawn is allowed to run at this temperature for five days. The temperature is then reduced to 65°, to avoid the risk of germinating "truffle" spores which may be in the compost. During the spawn run the growing rooms are closed and every effort is made to maintain a high humidity to prevent loss of water from the bed surface. We are inclined to believe that a dry layer over the bed surface at casing time tends to lower the yield. At times we have resorted to a very light watering during the spawn run with no apparent harm.

Casing Practice. All the experimental beds were cased with a Chester loam that had been heated to 150° F. to eliminate pests. This soil is slightly higher in clay content than that used ordinarily for casing in Chester County, Pennsylvania, and has an undesirable tendency to puddle and form a crust when watered. Therefore, the soil was moistened before it was applied to the beds and watering was reduced to a minimum until small mushrooms appeared on all areas of the soil surface. Acidity of the casing soil was adjusted to pH 7.5 by the addition of limestone to the soil pile. Care was taken to avoid using limestone with a high magnesium content because of its toxicity to mushrooms.

Cultural Practice. During and after the first flush of mushrooms water is applied in the usual manner and the casing soil is kept moist throughout the cropping period. The beds are dusted at ten-day intervals with a mixture of 1% Parzate (65% zinc ethylene bisdithiocarbamate) and 1% Lindane in an inert carrier. This dusting program effectively controls Verticillium spot and flies, and no off-taste from the Lindane has been detected in raw or cooked mushrooms. However, this dust is definitely not recommended for use in commercial practice until the possible residues on the mushrooms, and tolerances allowed by the Food and Drug Administration, have been determined.

Continuous, forced ventilation is supplied to the growing rooms throughout the cropping period. We believe that this is an important factor contributing to the high yields obtained. The ratio of air space to bed space in the growing rooms is about 6 cubic feet of air to 1 square foot of

bed. The air is renewed at the rate of 10 cubic feet per hour per square foot of bed space.

The temperature during the cropping period is held at approximately 60°F. The effect of the length of the cropping period on the yield of mushrooms is shown in Figure 7.

Factor Interactions. Four of the experiments were arranged so as to permit the simultaneous expression of the effect of the following paired factors on yield: depth of bed and duration of the second phase of pasteurization; packing and moisture content of compost; poultry manure supplement and moisture content; and packing and depth of bed. In some cases the separate and cumulative effects of the factors were clearly evident, but there was no clear-cut evidence of factorial interaction.

Tests in Commercial Houses. The two-phase system of pasteurization was given its first commercial trials in 1950 in the houses of the Brandywine Mushroom Company, West Chester, Pennsylvania, and of the Keystone Mushroom Company at Coatesville, Pennsylvania. Following these tests the system was used to prepare the compost for several hundred thousand square feet of bed space in these two establishments. It is evident from the experience gained in these houses that the system can easily be followed in commercial houses, provided an adequate source of auxiliary steam heat is available to attain the initial high pasteurizing temperature, and the houses are in good condition so that they will not be affected by this high heat. Increased yields of between 1/2 to 1 pound per square foot were obtained in commercial houses, but so far the increases have been disappointing when compared with the yields obtained in our pilot plant.

Discussion and Conclusions

The system of mushroom culture described above has been followed in four successive crops in our experimental growing rooms. The first objective that we set out to achieve has been attained; namely, the development of a system of pasteurizing that would enable the grower to raise his bed temperatures above 150° F., but keep his beds free from Chaetomium during spawn run. Such a system has obvious advantages in the control of harmful fungi, nematodes, and insect pests in the beds.

In our experimental rooms, yields of 5 pounds per square foot were obtained in beds filled at the rate of 97 square feet per ton of fresh manure. Yields of 6 pounds per square foot were obtained in beds filled at the rate of 73 square feet per ton. These yields are surprisingly high when compared with commercial yields. We are inclined to attribute the high yields to the accumulative effect of a number of favorable factors:

1. A poultry litter supplement seems to add about 1/2 pound of mushrooms per square foot to the yield.
2. The short outdoor composting (15 days), the high initial heat, and the comparatively low temperature of the second phase of pasteurization conserve carbonaceous material and possibly other essential nutrients.
3. The high temperature of the first phase undoubtedly eliminates most of the known harmful organisms and possibly some which have not been investigated.
4. The low temperature of the second phase is beneficial, probably through favorable nutrient changes and the conservation of moisture in the bed. Torula, a fungus which is very conspicuous at the end of this phase, appears to be associated with high yields.
5. The comparatively high heat-generating capacity of the compost, due to its "greenness" when placed in the beds, permits an aerated pasteurization of compost of high moisture content. The optimum moisture content of the compost at spawning time apparently is also somewhat higher than that of compost prepared in the usual manner. In this respect, it seems to be comparable to compost prepared by Sinden's method.
6. The continuous forced ventilation in our growing rooms provides an adequate supply of fresh air at all times.
7. The pasteurization of the soil undoubtedly reduces the population of harmful organisms.
8. The use of Parzate and Lindane on the surfaces of the beds permits continuous and extended cropping at approximately 60° F., with a minimum of accumulated diseases and pests. The use of Lindane is definitely not recommended for use in commercial houses until the Food and Drug Administration has set up tolerances for it.

As mentioned previously, the few commercial growers who have tried the "new" system have encountered no difficulty in following the temperature cycle during pasteurization, but the small increase in yields in commercial houses has been disappointing. The reasons for the failure of

commercial growers to obtain yields commensurate with our pilot scale tests have not yet been cleared up. It seems probable, in the light of the investigations of Middlebrook and Storey (3) and Storey and Edwards (4), that inadequate ventilation in commercial houses is at least one of the important limiting factors.

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AN IMPROVEMENT IN THE METHOD OF SEARCHING FOR HETERODERA CYSTS

A. L. Taylor, J. Feldmesser and G. Fassuliotis

Large numbers of soil samples are processed each year in the United States and foreign countries for the purpose of detecting cysts of plant parasitic nematodes of the genus Heterodera Schmidt, 1871. The procedures are generally variations of that described by Chitwood.[1] That is, the dried soil sample is mixed with water in a bucket, roiled vigorously and allowed to settle momentarily. The supernatant fluid is then poured simultaneously through two sieves, the first of 25 meshes to the inch and the second of 50 meshes to the inch, or finer. The process is repeated until only sand and gravel remain in the bucket. The material on the sieves is rinsed to wash all of the cysts through the first sieve and fine particles of soil and debris through the second sieve. The residue remaining on the second sieve is washed off and examined under the dissecting microscope for detection of the cysts. Since the greater part of this residue is composed of fragments of plant material in various stages of decomposition and often of about the same color as the cysts, thorough examination of it requires considerable time and a certain amount of experience.

Experiments have shown that, if stains are added to the residue, differential staining occurs so that the cysts can be distinguished from the debris by color as well as by form. Certain stains color the cysts and leave the debris unstained or stained a different shade from the cysts. Other stains color the debris and leave the cysts unstained. Of the two methods, the latter has been found preferable.

Stains suitable for this purpose are janus green, brilliant green, malachite green and gentian violet. The time required for staining depends on the concentration of the stain. Satisfactory staining is obtained in one hour with a solution of one gram of janus green in 4,000 ml. of water, one gram of brilliant green or gentian violet in 32,000 ml. of water, or one gram of malachite green in 64,000 ml. of water. If the residue is to be stained overnight, solutions of one half these concentrations can be used.

The procedure is a simple matter of adding the stain solution to the water containing the sieve residue and allowing it to stand for the specified time before the usual examination. It has been found convenient to make up a concentrated stock solution of the stain and to adjust the amount added so that the concentration after mixing is that required.

It is believed that use of this technique will result in a considerable saving of time and expense in the routine examination of soil samples and will reduce the necessity for experience on the part of the workers making the examinations. It may also facilitate the finding of cysts in lightly infested samples.

DIVISION OF NEMATOLOGY INVESTIGATIONS

[1] Chitwood, B.G. 1951. The golden nematode of potatoes. U.S. Dept. Agr. Circ. No. 875, 48 pp.

A SIMPLE GREENHOUSE METHOD FOR EVALUATING FUNGICIDES FOR CONTROL OF CUCUMBER ANTHRACNOSE

J. G. Atkins, Jr. and N. L. Horn

Since 1944, when anthracnose (Colletotrichum lagenarium) was first recognized as a serious foliage disease of cucumbers in Louisiana, various fungicides have been evaluated in field tests for control of anthracnose as well as downy mildew. Anthracnose has been a sporadic disease owing to the influence of environmental conditions (1). In some years the prevalence of anthracnose was not sufficient for field evaluation of the test fungicides. The various tests recently summarized for publication[1] showed conclusively that Fermate, Dithane Z-78, Parzate, and Orthocide 406 gave good control while others, such as Copper A Compound, Tri-Basic Copper Sulfate, Cop-O-Zink, Yellow Cuprocide, and Crag Potato Fungicide (658), gave poor or insufficient control. Recently some of the fungicides from the two groups, effective and ineffective, were tested in the greenhouse for comparison with the results obtained under field conditions. A method described by Dimock (2, 3) was used with slight modifications.

Cucumbers were planted in four or six inch pots, later thinned to approximately four plants per pot, and used in the inoculation tests when they were about six inches in height. The various fungicides to be tested were prepared double strength and diluted 1:1 with an aqueous suspension of conidia of the anthracnose fungus. Following agitation the respective mixtures were sprayed on the cucumber plants by means of a glass atomizer attached to a compressed air line. Control plants were sprayed with the conidial suspension diluted 1:1 with tap water. The plants were held in a moist chamber for approximately 60 hours following treatment. A second group of control plants which had not been inoculated were also placed in the moist chamber in some of the tests.

Tests 1 and 2

The fungicides used in the first test were those included in the 1951 field tests. The Marketer variety of cucumber was used with five replications for each treatment. The suspensions were sprayed on the plants within ten minutes following mixing. The test was started November 26 and completed December 3, 1951. The results obtained in the first test are given in Table 1 together with the fungicides evaluated. Figure 1 illustrates the range of infection.

FIGURE 1. Relative anthracnose infection on cucumbers from conidia suspended in Fermate 2-100 (left), Penn. Salt NP-492 2-100 (center) and water or control (right).

The relative severity of infection on plants used in the first greenhouse inoculation test was in agreement with the relative severity of field infection. In the 1951 field tests Experimental Fungicide NP-492 and Tri-Basic Copper Sulfate gave poor control, Crag Potato Fungicide gave poor to moderate control, and the other fungicides gave good control.

On February 2, 1952, the first test was repeated using four replications per treatment. Dilute conidial suspensions were used in order that the leaf spots could be counted. On February 8 the spots present were counted on all except the lower yellowish leaves, very young leaves and cotyledonary leaves. The results obtained, given in Table 1, were in agreement with those from the first test except possibly for Crag Potato Fungicide.

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[1] Unpublished manuscript.

Table 1. Relative anthracnose infection as a measure of fungicidal action against conidia of C. lagenarium.

Treatment	Spray formula[a]	First test: Relative infection	Second test: Average number spots per leaf
Control, not inoculated	--	None	0.0
Control, inoculated	--	Heavy	10.5
NP-492[b]	2-100	Heavy	5.0
Tri-Basic Copper Sulfate	3-100	Heavy	3.2
Crag Potato Fungicide (658)	2-100	Light	Trace
Fermate	2-100	Trace	0.0
Dithane Z-78	2-100	Trace	0.0
Parzate (dry)	2-100	Trace	0.0
Orthocide 406	2-100	Trace	0.0

[a] Pounds per 100 gallons.
[b] Experimental fungicide, Pennsylvania Salt Manufacturing Co.

Table 2. Greenhouse screening tests with various fungicides against Colletotrichum lagenarium.

Treatment	Dosage	Average number spots per leaf: Test No. 3	Test No. 4
Control	---	9.1	13.3
Phygon-XL	2-100	0.0	0.0
Vancide 51ZW	2-100	0.0	0.0
Manzate	2-100	0.0	0.0
Bioquin 1	2-100	0.0	0.0
Zerlate	2-100	0.0	Trace
Karathane	2-100	0.0	0.1
#5379[a]	2-100	0.0	0.0
Yellow Cuprocide	2-100	Trace	0.4
Copper Compound A	3-100	Trace	0.9
C. O. C. S.	3-100	0.3	2.2

[a] Experimental Fungicide, Carbide & Carbon Chemicals Co.

Tests 3 and 4

Eleven additional fungicides, listed in Table 2, were selected for inclusion in further tests. Two pots of cucumbers per treatment were inoculated on April 14 and 17, as tests No. 3 and 4. Leaf spots developing were counted on April 24. The results obtained are presented in Table 2. On the basis of the two tests all of the fungicides except Yellow Cuprocide, Copper Compound A, C. O. C. S., and probably Karathane would be expected to give promise in field tests.

Each inoculation series demonstrated that the copper fungicides were fungicidal in comparison with the controls since they reduced infection. However, they were less effective than any of the organic fungicides tested, with the exception of NP-492.

Discussion and Summary

The simple greenhouse test described gave results in agreement with those from field tests. Most of the fungicides listed in Table 2 were not tested in the field, however. The writers believe that a simple method, such as the one described, can be used to advantage in evaluating new or experimental fungicides in geographical areas where anthracnose, as well as downy mildew, must be controlled by a spray or dust program. Owing to the erratic behavior of anthracnose under field conditions, at least in Louisiana, more information might be obtained from greenhouse tests than from replicated field tests. The method should eliminate the necessity of testing all materials in the field. For example, Experimental Fungicide NP-492 need not have been included in the 1951 field tests since the material gave little or no control of anthracnose. In general, fungicides considered promising for late blight or downy mildew control by the manufacturer were those selected for field testing in Louisiana. Although a number of fungicides giving rather effective control of anthracnose, as well as downy mildew, were selected by the field-test method in Louisiana, the writers believe that the results from a greenhouse screening program would have provided additional information of value and perhaps resulted in a saving of time and money. The results obtained have been summarized because the various fungicide manufacturers are offering many new materials for testing and recent reports indicate that anthracnose has become a rather important disease of cucumbers in North Carolina (4) and South Carolina (5), in addition to Louisiana.

The method as described could probably be improved or standarized by the use of a standard fungicide included in each inoculation series, uniformity of spore suspensions, controlled greenhouse temperatures, etc. Since the method requires little skill, special equipment, or time, this method should perhaps be utilized more by plant pathologists working with cucumber anthracnose as well as other fungi which may be controlled by fungicides.

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LOUISIANA STATE UNIVERSITY, BATON ROUGE

SPRAY EXPERIMENTS FOR THE CONTROL OF FIRE BLIGHT ON APPLES AND PEARS, 1947-1950[1]

W. D. Thomas, Jr., and W. J. Henderson[2]

Fire blight (Erwinia amylovora) has been one of the principal limiting factors in the production of apples and pears in Colorado. It has been conservatively estimated that this disease causes an annual loss of about 10 percent of the entire apple and pear crops in the State, or about 157,000 bushels of apples and 19,900 bushels of pears.

Until 1947 only Bordeaux mixture had been used as a spray in Colorado to combat fire blight. Spray tests for the control of powdery mildew in 1946 in western Colorado, however, indicated that trees sprayed with Dithane D-14 in the cluster bud and calyx stage of blooming had far fewer spurs infected with fire blight than did the unsprayed checks.

Spray tests for the control of fire blight were established in Fremont and Mesa Counties of Colorado in 1947. The original experiments were designed to investigate the efficacy of carbamate fungicides in controlling this disease on apples and pears.

Spray Tests in 1947. In 1947 plots were established on pears in Mesa County and apples in Fremont County. Dithane D-14 and Zerlate were used in the former plot and Dithane D-14 only was used in the latter. Two quarts of Dithane were mixed with one pound of zinc sulfate and one-half pound hydrated lime per 100 gallons of water. Triton B-1956 (one ounce) and 50% DDT (two pounds) were added to all treatments. Check plots were sprayed with 50% DDT only. Applications were timed as indicated in Table 1.

The treatments were applied to three-tree blocks in four randomized replications. An unsprayed buffer row and an unsprayed three-tree buffer block was left between each sprayed row and block to prevent overlapping of spray materials. Observations were made by counting the total number of infected spurs on the center tree of each non-sprayed check and sprayed block.

Table 1. Results of spray tests for the control of fire blight on apples and pears in 1947.

Treatment	Time of application	Average number infected spurs		Percent reduction on number infected spurs	
		Pears	Apples	Pears	Apples
Dithane D-14	10% bloom	10.0	4.8	75.0	60.4
	Full bloom	16.7	3.3	62.5	72.9
	10% bloom and full bloom	13.2	3.8	67.5	68.7
	10% bloom, full bloom, and 90% petal fall	8.5	6.0	79.2	50.5
Zerlate	10% bloom	15.5	--	61.3	--
	Full bloom	13.0	--	68.0	--
	10% bloom and full bloom	13.5	--	66.8	--
	10% bloom, full bloom, and 90% petal fall	12.5	--	69.3	--
Check	Unsprayed	40.2	12.0	--	--
	LSD 5%	19.5	5.5	--	--
	LSD 1%	26.0	7.6	--	--

[1]Published with the approval of the Director, Colorado Agricultural Experiment Station as Scientific Journal Series No. 391.

[2]Plant Pathologist, Colorado Agricultural Experiment Station, and Plant Pathologist, Colorado Agricultural Extension Service, respectively.

The results shown in Table 1 indicate that the reduction of infection on pears by Dithane and Zerlate were highly significant, although there were no significant differences between the treatments or times of application, themselves. Effective control on apples was obtained when spray was applied at the full bloom stage, but when sprayed at the 10-percent bloom and again at full bloom stages results were highly significant.

Results were based on the count of infected fruit spurs, which were classified by an arbitrary index of infection from 1 to 6: (1) no infection; (2) 1 percent to 10 percent infection; (3) 11 percent to 30 percent; (4) 31 percent to 50 percent; (5) 51 percent to 80 percent; and (6) 81 to 100 percent.

Because growers maintain that a 50-percent control of a heavy infection of fire blight in an orchard allows sufficient new growth and set of healthy fruit for a satisfactory crop, and since more than 50-percent control was obtained in these tests, similar tests were conducted in 1948 and 1949.

Spray Tests in 1948. In order to determine whether or not zinc sulfate was instrumental in securing control of fire blight, this chemical was used at the rate of two pounds per 100 gallons of water. Dithane Z-78 and Puratized Agricultural Spray were also used as treatments applied at the rates and stages indicated in Table 2. Triton B-1956 (1 oz. per 100 gal.) was added to all spray materials. No DDT was used in 1948. No treatments were used on the checks. The methods and locations in 1948 were similar to those used in 1947.

As shown in Table 2, Dithane Z-78 gave a significant reduction of fire blight on pears when applied at the full-bloom stage. There was also a highly significant reduction in the percentage of infected spurs on both apples and pears when Dithane Z-78 was applied at both the 10-percent bloom and full-bloom stages. However, an additional application made in the 90-percent petal fall stage failed to give a significantly better control than an application in the 10-percent bloom followed by an application in the full bloom. This was undoubtedly due to the short blooming period under Colorado conditions. In States where the blooming period covers a longer time, an application in the 10-percent bloom followed by applications in the full-bloom and 90-percent petal fall would be needed. Neither Puratized Agricultural Spray nor zinc sulfate gave satisfactory control of fire blight in these tests.

Spray Tests in 1949. In 1949 the tests were conducted on apples only in Montrose County. An entire orchard was included in this test and consisted of 118 Jonathan trees and 114 Delicious trees. The varieties alternated in the rows. Two check blocks of nine trees each were left unsprayed in the orchard. All other trees were sprayed with Dithane Z-78 (2 lbs. per 100 gals. water) to which Triton B-1956 (1/2 oz. per 100 gals.) was added. Applications were made at the 10-percent bloom stage with subsequent applications in the full-bloom stage.

For the Jonathan variety results show that 88.1 percent of the sprayed trees and 33.3 percent of the unsprayed trees had from none to a trace of infected spurs; 8.5 percent of the sprayed trees and 39.0 percent of the unsprayed trees had from 1 to 10 percent infection; 1.7 percent of the

Table 2. Results of spray tests for the control of fire blight on apples and pears in 1948.

Treatment	Rate of application and stage of bloom when applied		Percent infected spurs		Percent control over check	
	Per 100 gal.	Bloom stage	Pears	Apples	Pears	Apples
Dithane Z-78	2 lbs.	Full	5.4	8.2	66.7	37.0
	2 lbs.	10% + full	0.8	1.1	95.1	91.0
Puratized Agricultural spray	1 pt.	Full	17.5	--	- 1.3	--
	1 pt.	10% + full	25.0	--	-64.8	--
Zinc sulfate	2 lbs.	Full	22.5	11.3	-72.0	15.0
	2 lbs.	10% + full	12.5	7.8	-22.8	22.6
Check	--	--	16.2	13.3	--	--
		LSD 5%	6.4	6.0	--	--
		LSD 1%	8.7	8.4	--	--

sprayed trees and 22.3 percent of the unsprayed trees had from 11 to 30 percent infection; and 1.7 percent of the sprayed trees and 5.6 percent of the checks had from 31 to 60 percent infection.

Of the Delicious variety, 97.7 percent of the sprayed trees and none of the unsprayed trees had from zero to a trace of infected spurs; 8.5 percent of the sprayed trees and 39.0 percent of the check had from 1 to 10 percent infection. None of the sprayed trees had any greater infection. Of the check trees, however, 55.5 percent had from 11 to 30 percent infection.

Spray Tests in 1950. In 1950 the same procedure was used as in 1949 on Jonathan trees in the same orchard, with the exception that three entire rows were left at random as unsprayed checks. Approximately 50 percent of the trees in the unsprayed check had a medium amount of twig infection and only a trace of fire blight occurred in the sprayed trees.

SUMMARY: In spray tests conducted on apples and pears at several locations in Colorado in 1947, 1948, 1949, and 1950 for the control of fire blight, it was found that applications of Dithane Z-78 (2 lbs. per 100 gals. water) in the 10-percent bloom and a subsequent application in the full-bloom stage reduced the incidence of current season blossom and twig infection approximately 75 percent.

This spray method, together with sanitary pruning and treatment of hold-over cankers, has become a standard recommendation for fire-blight control in Colorado.

It is recognized that in areas where the blossoming period is considerably longer than that where these investigations were conducted, an additional application should be made about the 90-percent petal-fall stage of blooming.

COLORADO AGRICULTURAL EXPERIMENT STATION AND COLORADO AGRICULTURAL EXTENSION SERVICE

CYTOSPORA CANKER OF APPLE IN NEW MEXICO

Philip J. Leyendecker, Jr.

A survey made during March 1952 in San Juan County, New Mexico revealed that a canker-forming fungus was responsible for severe tree damage in many of the apple orchards in that area.

The extent of damage in any one orchard depended upon the percentage of Rome Beauty trees present, since the damage was primarily confined to that variety. Apparently the disease severity was not influenced by age of trees or conditions which affected their vitality. On one four-year old orchard, showing excellent terminal growth, the disease killed 85 percent of the Rome trees and injured the remaining 15 percent.

Rome Beauty is not considered to be exceptionally winter hardy in New Mexico. In most instances the fungus appeared to follow winter injury and sun scald; over 80 percent of the injury was found on the southwest side of the trunk and in the crotch tissue. Considerable secondary spread was found following pruning wounds where, no doubt, infested pruning tools had spread the spores. It is believed that the unusually low winter temperatures during 1950 accounted for the extreme expression of this disease which appeared in 1951 and 1952.

Isolations from active cankers produced a species of Cytospora not distinguishable from C. leucostoma, which was reported by Leonian on apple trees from New Mexico in 1921. This organism has been recently reported from Colorado as causing a similar condition on peach trees, referred to as "gummosis."

Old cankers in most instances were covered with small, black, erumpent pycnidia which produced gelatinous orange tendrils under conditions of high humidity. Figure 1 shows a typical canker covered with fruiting bodies of the fungus. The mycelium appeared to be perennial, becoming active early in the spring as air temperatures increased. A soft, pulpy, discolored condition of the bark resulted as the mycelium invaded the tissue contiguous to the old canker. The invaded tissue could be macerated by a slight pressure with the thumb nail. Virulence of the pathogen was evidenced by the fact that orchardists reported that small trunks were girdled in only one or two weeks in early spring when temperatures appeared to be optimum. They also observed that as temperatures increased the activity of the pathogen was retarded, and the infected areas appeared to become dessicated and remain inactive until the following spring.

FIGURE 1. Cytospora canker of apple.
A. Inactive canker on Rome Beauty branch showing black pimple-like pycnidia.
B. Same canker after 12 hours in a moist chamber showing gelatinous exudate.

It was of interest to find that certain control measures apparently were very effective in checking canker enlargement and secondary spread. In a number of orchards active cankers were removed by cutting away the infected bark and painting the wounds with a Bordeaux paste. Other orchardists checked canker enlargement by spraying the infected areas with a 4-4-50 Bordeaux mixture at very high pressures. The force of the spray stream actually removed the infected bark and deposited a film of protective fungicide.

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NEW MEXICO AGRICULTURAL EXPERIMENT STATION, STATE COLLEGE, NEW MEXICO

NOTES ON EARLY SEASON PATHOLOGY OF FLUECURED TOBACCO IN SOUTHSIDE VIRGINIA AND PORTIONS OF THE OLD BELT IN NORTH CAROLINA

Wilbert A. Jenkins

Blue Mold (Peronospora tabacina): This disease was rarely seen in "active" form during the entire plant bed season, though "dry weather" mold was common. The latter is characterized by essential absence of sporulation but with chlorotic foliar spots dotted with necrotic lesions of varying size and number. In given areas, quite locally, blue mold occurrence did approach an epiphytotic, but these situations responded well to treatment and bright weather without serious losses of plants. It is the writer's opinion that climatic conditions constituted the greatest factor this season in blue mold control, in spite of the facts that ferbam treatments were the general rule and that rather long periods of cool, rainy weather prevailed.

Anthracnose (Colletotrichum sp.): This disease was first recognized by the writer in Virginia during the 1944 season (PDR 28: 838, 1944) and it has occurred sporadically during odd seasons since then. At no time has the disease been widespread and the present season is no exception. Two aspects of the disease, as seen in Virginia, are worthy of comment for possible future reference. Ferbam has consistently failed to control anthracnose in the growers' plant beds, notwithstanding reports from elsewhere indicating good control with this material. Since the disease has never been seen on the Experiment Station plant beds, the writer has no positive proof of the failure of ferbam other than the growers' statements and the physical evidence of heavy ferbam deposits on anthracnose plants. In every instance, zineb controlled anthracnose, even though such treatments were not begun until after the disease had been identified and zineb supplied by the writer. Supposedly, the growers performed no more careful treatments with zineb than with ferbam, for they were strictly on their own with both treatments. For the record, zineb was recommended at the rate of 1 1/2 pounds per 100 gallons of water.

Field losses from anthracnose have been noted on two occasions during the past eight seasons. During 1949, a single field was seen in which heavy potential losses from anthracnose were indicated, since during a period of rainy weather immature leaves were breaking from the plants owing to midvein and petiolar lesions. Losses were not heavy, however, because bright, sunny weather soon followed and the disease disappeared. During the current season, one grower found it necessary to plow up and re-set about six acres of tobacco severely affected by anthracnose. These fields had been set from seedlings imported from eastern North Carolina and were obviously infected while in the plant beds.

Root Rot Disease-Complexes: A report on this subject has already been submitted (PDR 36: 254, June 1952) and the only additional information concerns carry-over to the field. In several instances, newly set crops from affected beds have required considerably more replanting than those set from non-affected beds. The final results must be evaluated later, as complications resulting from or following root mutilations, particularly in soils harboring wilt and black shank pathogens, are not visible at this time. Several fields were known to be set from beds carrying low root-knot infestations, but the effects of this situation must also be evaluated later.

Black Shank (Phytophthora parasitica var. nicotianae) has been active and killing newly set plants since June 2, both in our experimental plots and in an increasing number of growers' fields. The current set-back of many plantings, by unusually dry weather accompanied by high air and soil temperatures, may be expected to favor early infections that may induce heavy losses later, provided drought stresses or other unfavorable factors are brought to bear on the crops. Such a situation will have little relationship to losses in strictly agronomic varieties but may cause unexpectedly heavy losses in the resistant varieties.

Miscellaneous: Seedling diseases, accompanied by stand losses, due to Pythium and Rhizoctonia have been prevalent this season on newly set plants in the field. Owing to the generalized type of syndrome these organisms induce, and particularly because black shank or wilt infections may also be present in such seedlings, proper diagnosis has caused the growers and some of our personnel much worry. As a matter of fact it should be freely admitted that field diagnosis of such diseased seedlings is at best a precarious procedure. In the laboratory, with the microscope and other aids, diagnosis is relatively easy, provided, of course, that the collection of specimens is sufficiently large and that it is in good condition for inspection.

Excessively dry and hot weather which has prevailed during most of the current week (June 2 to 6) has lowered the stand count in fields over wide areas where stands had been almost perfect prior to the advent of the week of excessive heat and drouth.

VIRGINIA AGRICULTURAL EXPERIMENT STATION, TOBACCO DISEASE RESEARCH AND SEED FARM, CHATHAM

PYTHIUM ROOT AND STEM ROT OF LUPINES[1]

J. L. Weimer[2]

A considerable number of dead and dying blue (Lupinus angustifolius L.) and white (L. albus L.) lupine plants approaching maturity were present in some fields at Experiment, Georgia, in the spring of 1948. Isolations from many of these affected plants showed that a species of Pythium was consistently present in the roots and stems. Since that time a number of lupine plants grown in the greenhouse have been killed after they had passed the seedling stage by what appeared to be the same disease. At no time has the disease reached epiphytotic proportions, but a considerable number of plants in limited areas in some fields have been killed.

SYMPTOMS

The disease was first observed in a field of blue lupine plants in the early blooming stage. At first glance the disease closely resembled that caused by Sclerotium rolfsii or Sclerotinia sclerotiorum. Closer examination, however, soon showed characteristic differences. Leaves of plants affected with the Pythium disease first wilted and then died, but remained attached to the plants for some time. The diseased plants with their dead leaves clinging to them were quite conspicuous among healthy plants which were maturing and shedding their leaflets in a normal manner. Plants affected early wilted and died without setting seed, whereas those infected later set some seed, most of which, if they matured at all, were small and usually shrunken. Affected plants could be pulled from the soil easily since their roots were almost completely destroyed. The diseased roots, before being too badly decomposed, varied from dark brown to almost black in color.

Large white lupine plants affected with the disease also wilted and died. The roots were dark brown to nearly black in color and were eventually partially or wholly decayed.

The earliest above-ground symptom of this disease on blue lupine plants growing in pots in the greenhouse was a change in color of the base of the stem from green to dark brown and finally to almost black. The discoloration gradually progressed up the stem, sometimes to a distance of a foot or more, depending on the height of the plants, but usually not at a uniform rate throughout the circumference. The tissue beneath the bark of the green part of the stem above the discolored area was darkened for a considerable distance. The leaflets of the affected plants turned yellow from below upward, wilted, and gradually dried up but tended to cling to the stems. Plants that had been killed or were dying from this disease are illustrated in Figure 1. Half or more of the lower leaves of some dying plants were dead, while a small number of green leaves at the apex of the stem were still green. Under other conditions fairly large plants were killed in two or three weeks. The fibrous roots of diseased plants were eventually destroyed by a moist brown rot. The woody cylinder of the upper part of the root and the base of the stem was brown to almost black.

ISOLATIONS AND INOCULATIONS

The causal fungus was readily isolated by making platings from the subepidermal tissue of diseased plants from the field and greenhouse on corn meal agar. Greatest success was had when isolations were made from tissue some distance above the soil where secondary invasion had not yet occurred. The fungus grew rapidly, covering the petri dish in about three days.

Blue lupine plants in the early blooming stage growing in six-inch pots in the greenhouse were inoculated by first removing the soil from the base of the stem, placing against the exposed part a segment of agar culture cut from a petri dish and then replacing the soil over the inoculum. The tissue thus inoculated was not intentionally injured but it is probable that some superficial injury was caused when the soil was removed. Twenty plants were inoculated in this manner on April 22, 1948. Ten plants treated in the same manner as those inoculated, except that sterile agar was used instead of the culture, served as controls (Table 1). Five days after the inoculations were made 8 of the 20 inoculated plants were beginning to wilt, and the characteristic blackish discoloration was evident on some stems just above the surface of the soil. The condition of the plants in

[1]Cooperative investigations of the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, and the Georgia Experiment Station.

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FIGURE 1. Blue lupine plants in pot at left served as controls and are all healthy. Plants in pot at the right were inoculated and several are dead or dying. X about 1/7.

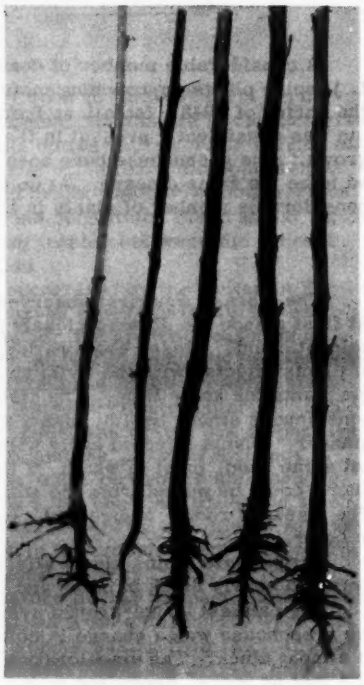

FIGURE 2. The blackened bases of some of the plants from the pot at the right in Figure 1 show how far up the stems the disease has progressed. X about 1/2.

a control and in one pot of the inoculated plants on April 30 is shown in Figure 1. A close-up of the darkened bases of the infected stems and roots is shown in Figure 2. Although all of the inoculated plants became infected only 14 of them died eventually. The remaining 6 plants had cankers at the point of inoculation but were still alive when the experiment was discontinued on May 10. All of the control plants remained healthy. The interior of the roots of the diseased plants was light brown. The discoloration extended up the stem in the form of a brown ring resembling that characteristically present in plants affected with Fusarium wilt. This color was the result of gummy deposits in the lumina and walls of the ducts and the walls of adjacent cells.

A second set of inoculations was made on May 7, 1948, using several pure lines of the isolate used in the first experiment and the same method as before. The plants were slightly older than those used previously, some having mature pods. On May 20 the 13 control plants were healthy, while 34 of the 50 inoculated plants were dead (Table 1). The fungus used in the inoculations was reisolated from several plants showing typical symptoms of the disease. The results of these experiments show that the fungus isolated from the large diseased lupine plants in the field was capable of reproducing the characteristic symptoms in large plants under greenhouse conditions.

On February 28, 1952, five isolates of the Pythium from lupines were used to inoculate a number of blue and white lupine plants growing in pots in the greenhouse. Segments of agar on which the fungi were growing were placed against the slightly injured base of the stems, which were then covered with soil. The results of this experiment are given in Table 2. Just why only a few plants became infected is not clear. Possibly more severe injury was needed or the temperature was too low. Since some of the isolates used had been tested previously, lack of

Table 1. Infection resulting from inoculating blue lupine plants with Pythium in the base of the stem beneath the soil surface without wounding.

Date (1948)	Number of plants: Inoculated	Control	Infected	Infected (Percent)
April 22	20	--	20	100
	--	10	0	0
May 7	50	--	34	68
	--	13	0	0

Table 2. Infection resulting from inoculating blue and white lupine plants with four isolates of Pythium from lupine. Inoculum placed against the slightly wounded base of the stem just beneath the soil surface.

Number of plants inoculated		Number of plants infected		Percentage of plants infected	
Blue	White	Blue	White	Blue	White
12	10	2	0	16.7	0
7	0	1	0	14.3	0
6	0	1	0	16.7	0
12	7	2	1	16.7	14.3
5*	3*	0	0	0.0	0

*Controls

infection in this experiment cannot be attributed to lack of pathogenicity.

On March 26, 1952, a number of plants were inoculated in order to determine if a higher percentage of infection could be obtained if the fungus was placed in deeper wounds. The inoculum in some plants was inserted beneath the bark in wounds with a sharp sterile scalpel, while in others the inoculum was placed against the uninjured surface of the stem. In both cases the inoculum was held in place with Scotch tape with or without moist cotton immediately over it. The plants used were growing in pots in the greenhouse and were up to three feet tall. Some stems were inoculated near the surface of the soil and others a foot or more above. In no case did infection take place when the inoculum was applied directly to the uninjured stem (Table 3). None of the controls, plants treated as were those inoculated except that the inoculum was replaced with sterile agar, were infected. The presence of the cotton over the inoculum made no difference in the amount of infection. Five out of 10 plants inoculated through wounds with the isolate used in the 1948 experiments showed infection in two days, and the lesions enlarged rapidly, being two to six inches long in 16 days. The five plants inoculated with the more recently isolated fungus all became infected, and the lesions were from three to nine inches long in 16 days. Four of the 15 plants inoculated were dead or nearly so in 16 days. All parts of the stems were susceptible. This experiment, although conducted on a small scale, indicated that wounds are necessary for infection, at least on such old plants. These experiments demonstrate that the Pythium commonly associated with the diseased tissue of large plants in the field and in the greenhouse is highly pathogenic.

Table 3. Infection resulting from inoculating blue lupine plants with two isolates of Pythium from lupine. Inoculum placed in deep wounds (beneath the bark) or directly on the unwounded bark of the stem above the surface of the soil.

Number of Plants: Inoculated	Controls	Infected	Percent infected	Location of inoculum and date fungus was isolated
10	--	6	60	In wound - 1948
5	--	5	100	In wound - 1952
8	--	0	0	Unwounded surface - 1952
--	5	0	0	

THE CAUSAL FUNGUS

Diseased tissue from near the base of the stem contained typical Phycomycetous mycelium 3 to 6 μ in diameter, a large number of conidia, and some oospores. The conidia were terminal or intercalary, tended to be globose, elliptical, or pear-shaped, but were sometimes barrel-shaped, had thin walls, were slightly brownish in color, and had coarsely granular contents. The conidia ranged from 14.7 to 25.2 μ (av. 20.3 μ) in diameter. They germinated by germ tubes. No zoospores were formed by the fungus when held in several changes of water over a period of several days. When pieces of diseased tissue were placed in water the mycelium grew out into the water and formed conidia in considerable abundance. Oogonia and oospores were present in the dead tissue but were more easily studied on corn meal agar. On this medium the oogonia usually were spherical, terminal or intercalary, colorless to light brown, densely granular, had a thin smooth wall, and ranged from 16.8-27.3 μ (av. 21.5 μ) in diameter. Usually there was only one antheridium to an oogonium. This commonly arose from the same mycelial branch and just below the oogonium, but less frequently from a neighboring hypha. Antheridia commonly curved so that only the tip of the antheridium made contact with the oogonium. The oospores did not completely fill the oogonium. The oospores were single, spherical or nearly so, densely granular, very light brown, had a wall that averaged 1.85 μ (50), had a single central reserve globule and refringent body, and measured 11-25 u (av. 19.3 μ) in diameter.

The characteristics of the fungus studied indicate that it is at least very similar to Pythium debaryanum Hesse and P. ultimum Trow. Certain characters more closely resemble those of the latter species. For example, the antheridia are typically monoclinous and there is rarely more than one to an oogonium, whereas P. debaryanum commonly has two to six antheridia to an oogonium. Drechsler (1) states that the oospore walls of P. debaryanum are 1 ± μ while those of P. ultimum are 1.5 ± μ thick. Middleton (2) says the oospore wall of P. debaryanum does not exceed 1.5 μ in thickness, whereas that of P. ultimum usually is at least 2.0 μ thick. The spores of the fungus studied by the writer had walls that ranged between 1.5 to 2.0 μ (av. 1.85 μ), hence were more nearly like those of P. ultimum. The asexual spores formed by the writer's fungus germinated by germ tube. Zoospores were never seen. Since the fungus studied is morphologically more nearly like P. ultimum than P. debaryanum it is referred to that species.

It is of interest that a similar disease of lupines which occurs in Europe is said to be caused, at least in part, by P. debaryanum. Noll (3) describes such a disease on Lupinus angustifolius, L. luteus, and L. albus. He isolated a number of fungi from such diseased plants, largely Rhizoctonia solani, Fusarium spp., and Pythium debaryanum, the fungus isolated varying with the source of the infected plant and the species of lupine. Schultz (4, 5) made a detailed study of the role of Pythium spp. as agents of lupine root rot and found that Pythium debaryanum was most pathogenic to lupine of any of the Pythiums studied.

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DIVISION OF FORAGE CROPS AND DISEASES, U. S. BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AND GEORGIA AGRICULTURAL EXPERIMENT STATION

DISEASES OF BROME GRASSES IN GEORGIA[1]

E. S. Luttrell[2]

Although none of the brome grasses are utilized to any significant extent for forage in Georgia, two of these grasses, smooth brome grass (Bromus inermis Leyss.) and rescue grass (B. catharticus Vahl), show some promise as winter grazing crops and are being tested on an experimental basis. Smooth brome is being considered because of the high quality of its forage and because it is a perennial grass which might furnish grazing at all seasons of the year. There is a possibility (1) that strains of this grass suitable for use at least in the northern mountainous region of the State may be selected. The only permanent pasture grasses for winter grazing grown extensively at present are tall fescue grass and orchard grass. Rescue grass may be employed for temporary winter grazing in the same manner as Italian rye grass, which is generally used for this purpose. Rescue grass has several advantages. It will reseed even more readily than rye grass. Also, it makes more rapid fall and early winter growth and, under favorable conditions, will produce satisfactory growth throughout the entire year. However, it is more susceptible to cold injury, and it is doubtful that it can equal rye grass in forage production.

Few diseases have been observed on smooth brome grass and rescue grass in Georgia during the period 1949-52. Several of these diseases, however, are of sufficient severity to deserve primary consideration in the development of strains of these grasses adapted to Georgia conditions.

Smooth Brome Grass

Smooth brome grass has been observed in test plots at Blairsville in North Georgia, Experiment and Eatonton in the Piedmont, and Dublin in the upper Coastal Plain. Only three diseases have been found in these plantings. Rhizoctonia blight is the most serious of these diseases and apparently is one of the critical factors limiting the establishment of this grass in Georgia. Spot blotch also is a serious disease. The third disease, Cercospora leaf spot, at present appears to be of minor importance. These are primarily diseases of the foliage, and all occur during the summer months. Nevertheless, all of them may reduce the amount of forage accumulated for fall grazing, and Rhizoctonia blight may largely destroy the stands.

Rhizoctonia Blight (Rhizoctonia solani Kuehn): Infection with Rhizoctonia blight was severe during the summer of 1949 when rainfall was unusually heavy. In July the damage it caused was estimated at 60 to 70 percent at Eatonton and 25 to 30 percent at Blairsville, and by the end of the summer stands of smooth brome were seriously reduced. The disease was serious again at Eatonton in July 1950, when damage was estimated at 60 percent. However, at Dublin in the same period it was not present, and in the absence of the blight smooth brome here presented a better appearance than either rescue grass or tall fescue, although this location is far south of the region in which smooth brome could be expected to prove adapted. Remnants of the original stands were still present at Eatonton and Blairsville in the summer of 1951, but the surviving plants were again heavily infected in August. Moderately heavy infections occurred at Experiment in spite of conditions of extreme drought during most of the summer. The disease disappeared at the beginning of cool weather in the fall.

The symptoms of the disease (Fig. 1) were similar to those of Rhizoctonia blight of tall fescue (3). Large pale grayish-brown blotches outlined by irregular, narrow, dark-brown borders formed in the leaf blades. The mycelium of R. solani was visible under the hand lens as an appressed cobweb on the surface of young blotches. Infected leaves died back, the leaf sheaths became infected, and ultimately many plants were killed entirely. Rhizoctonia blight appears to be even more serious on smooth brome than on tall fescue since death of mature plants rarely occurs in tall fescue.

Spot Blotch (Helminthosporium sativum Pam., King, & Bakke): Spot blotch was commonly present on smooth brome at all locations during the summer of 1949. Estimates indicated that in July 60 to 80 percent of the leaves were infected, although estimates of damage caused hardly exceeded 10 percent. The disease may be of greater importance than is indicated by these estimates. Rhizoctonia blight also was generally present and may have obscured the effects of spot blotch since the greater proportion of the damage was attributed to the blight.

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[2]With the collaboration of O. E. Sell and E. M. Parker, Animal Industry Department; J. M. Elrod, Agronomy Department, Georgia Experiment Station; and O. L. Brooks and M. B. Parker, Georgia Mountain Experiment Station.

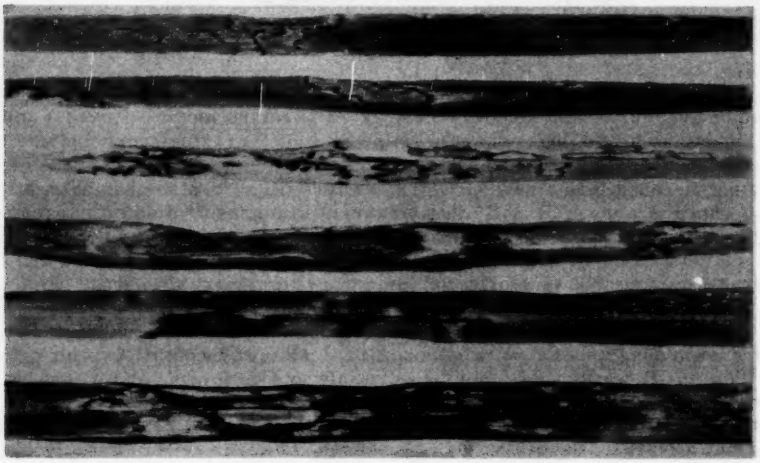

FIGURE 1. Blight of smooth brome grass caused by Rhizoctonia solani.

Only traces of spot blotch remained by November. This disease was generally less abundant during the drier summers of 1950 and 1951, although severe infection was found in a nursery at Experiment during a drought period in May 1951.

Infected leaves were heavily spotted and died back from the tips. The lesions ranged from tiny brown flecks 0.2-0.3 mm. in diameter to oblong dark-brown spots up to 6 x 0.8 mm. in size. Small buff-colored areas frequently appeared in the centers of the larger spots. Conidiophores and conidia produced on the dead tissue of infected leaves were typical of H. sativum as described by Drechsler (2). Dimensions of conidia from smooth brome were 46.2-117.6 x 15.4-21.0 μ (av. 25 = 95.4 x 18.6 μ).

Cercospora Leaf Spot (Cercospora festucae Hardison): Cercospora leaf spot was not observed on smooth brome in 1949. Possibly it was obscured by the heavy infections with Rhizoctonia blight and spot blotch. It was found in trace amounts in the early fall of 1950 and was much more abundant at Experiment in the late summer of 1951, approaching spot blotch in importance. The spots were subcircular to oblong with wide dark-brown margins and white to tan centers and measured 0.8-3.5 x 0.8-1.5 mm. C. festucae produced conidia abundantly on the dead tips of leaves held in a moist chamber. The conidia were similar to those on tall fescue (3). They were attenuate-obclavate, hyaline, and multiseptate, and measured 92.4-420 x 4.2-5.3 μ (av. 25 = 293.7 x 5.2 μ).

Occasionally it may be possible to confuse Cercospora leaf spot lesions with spot blotch lesions. The former are often solid in color and fail to produce typical eye spot, while the latter may exhibit pale-colored centers. In case of doubt it is necessary to turn to signs of the causal fungi. Both sporulate abundantly on infected leaves placed in a moist chamber, and Helminthosporium sativum is readily isolated from the lesions it causes. C. festucae is more difficult to isolate since the cultures are usually overrun by faster-growing secondary molds.

Hendersonia culmicola var. minor Sacc.: At Eatonton in 1949 the dead tissue of Rhizoctonia blight lesions was filled with pycnidia of a Hendersonia species which appeared to be only a secondary organism. The conidia of this fungus were fusiform or cylindric, 1-3 (typically 3)-septate, slightly constricted at the septa, and pale yellowish-brown. They measured 12.2-23.0 x 2.9-3.8 μ (av. 25 = 17.7 x 3.1 μ). This fungus is tentatively referred to H. culmicola var. minor (4).

Brachycladium spiciferum Bain: In September 1949 at Blairsville a few late seed heads of smooth brome were found which were assumed to be infected with spot blotch. However, isolations from the blotched glumes yielded a Helminthosporium-like fungus with small, consistently 3-septate conidia. These conidia were oblong, thin-walled, and fuligenous to brown, and measured 18.2-37.2 x 6.1-9.1 μ (av. 25 = 29.1 x 8.3 μ). They were borne in dense heads on the conidiophores. The conidiophores were brown and were covered toward the apex with numerous

spirally-arranged conidial scars. This fungus appears to be similar to material which Sprague (4) referred to B. spiciferum.

Rescue Grass

Rescue grass has been observed in test plantings in the same locations as smooth brome and also in naturally occurring stands in waste places. Only two important leaf diseases have been found. Powdery mildew is generally present during the spring but disappears with the advent of hot summer weather. It occurs at a time when the grass would be in the process of utilization and when seed are being produced and thus may reach serious proportions. However, its development so far has been sporadic. Spot blotch is so common throughout the warmer months from spring until fall that it is almost a characteristic of the grass. Neither of these diseases is of sufficient importance to discourage utilization of this grass, but resistant strains would be highly desirable. Rhizoctonia blight has been found only once on rescue grass, which appears to be highly resistant to this disease. Head smut has been found only infrequently, but is serious enough to make seed treatment advisable.

Powdery Mildew (Erysiphe graminis DC.): During the mild winter of 1949-50 powdery mildew was observed as early as January 1951 in naturally occurring stands of rescue grass at Experiment. During the spring the disease became severe, as many as 90 percent of the leaves being infected in some stands. However, nearby nursery plots were nearly free of infection. Powdery mildew began to disappear in early June, and by the end of June only traces of it remained. Little rescue grass survived the severe winter of 1950-51, and powdery mildew did not appear on the remaining plants until May when scattered infections were found. It again disappeared by the end of June. The disease was as serious during the spring of 1952 as it had been in 1950. At Experiment infection was much more severe on Texas rescue 46 than on common rescue grass. There appeared to be considerable variation in susceptibility among individual plants of common rescue grass. Some gave a hypersensitive reaction. On these plants there was an early necrosis of the leaf tissue at the point of infection accompanied by limited growth and fruiting of the fungus mycelium.

Powdery mildew appeared as fluffy patches of white mycelium on both surfaces of the leaves. The leaf tissue beneath the mycelium turned yellow and finally died, forming irregular brown spots in the leaf. The mycelium then turned brown, matted down, and disappeared. The numerous brown spots that remained in the leaves in June were not easily recognized as powdery mildew lesions unless they were carefully examined under the hand lens for remnants of the superficial mycelium.

The conidia of the causal fungus, which were borne in chains at the tips of simple erect conidiophores, were nonseptate, oblong, and hyaline. The protoplast was granular in young conidia, but in fully mature conidia it was perfectly clear and contained a few large clear globules. In one collection fully mature conidia measured 32.2-50.4 x 12.6-16.5 μ (av. 25 = 40.2 x 14.3 μ). Since these dimensions exceeded those generally reported for the conidia of Erysiphe graminis, a second lot of conidia from rescue grass was measured on February 12, 1952 and compared with conidia of E. graminis from wheat collected in the same location on the same day. These measurements were as follows: on rescue grass, 30.8-42.0 x 14.0-18.2 μ (av. 25 = 37.4 x 16.5 μ); on wheat, 28.0-42.0 x 14.0-16.8 μ (av. 25 = 37.4 x 15.2 μ). No perithecia of E. graminis have been found on rescue grass.

Spot Blotch (Helminthosporium sativum Pam., King, & Bakke): Spot blotch was severe at all locations throughout the summer of 1949. This season was especially favorable for rescue grass, however, and it made excellent growth in spite of the disease. In many locations 70 to 90 percent of the leaves were infected, and damage was estimated at 10 to 40 percent. Only traces of spot blotch remained by November in the Piedmont, but in January 1950 at Dublin 20 percent of the leaves were infected. The disease developed to nearly the same extent in 1950, and again appeared on the plants that survived the winter in 1951.

Infected leaves were densely covered with oblong to rectangular brown spots (Fig. 2, A) 0.5-16 x 0.5-2 mm. in size. The spots often elongated and became confluent, the surrounding tissue yellowed and died, and the entire leaf died back from the tip. Tiny buff-colored areas appeared in the centers of some of the spots. Conidiophores and conidia formed on the dead leaves were typical of H. sativum (2). Dimensions of conidia from rescue grass were 44.8-114.8 x 16.8-22.4 μ (av. 25 = 85.6 x 18.6 μ). Traces of infection were found on seed heads at Experiment in June 1949 and scattered seed heads that appeared later in the summer were heavily spotted (Fig. 2, B). The lesions on the glumes and branches were similar to those on the leaves. Isolations from glume lesions yielded cultures of H. sativum.

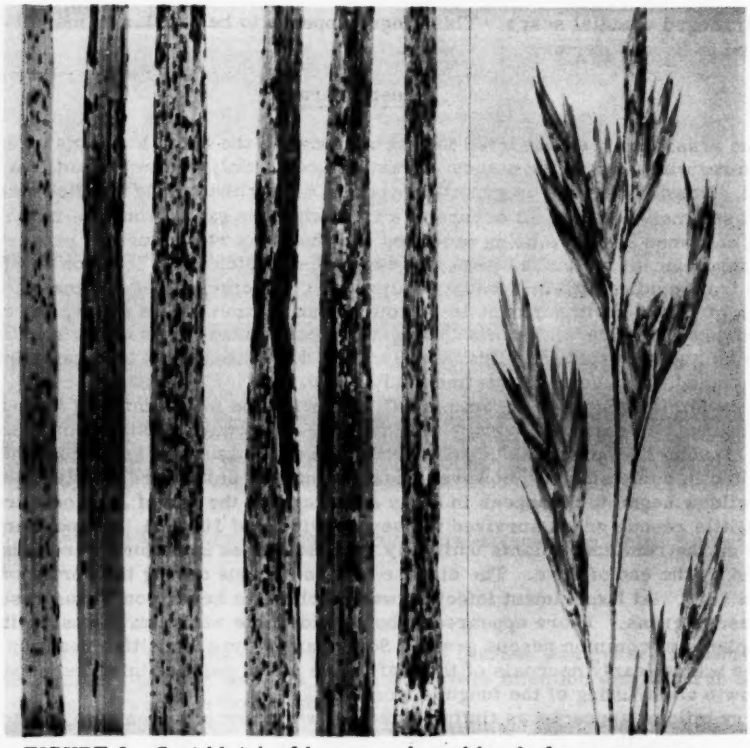

FIGURE 2. Spot blotch of leaves and seed head of rescue grass caused by Helminthosporium sativum.

Rhizoctonia Blight (Rhizoctonia solani Kuehn): Rhizoctonia blight was found at Blairsville in August 1951 on plants of rescue grass growing in a mixed stand of tall weeds and other grasses. The lower leaves of these plants were infected, and up to 25 percent of the leaves were killed. Typical blotches similar to those on smooth brome grass were found on the leaves.

Head Smut (Ustilago bullata Berk.). At Experiment in April and May of 1949 heavy infection of head smut occurred in a test plot of rescue grass seeded the preceding fall. Ths disease has not reappeared in this plot in succeeding years and has not been observed at all in naturally re-seeded stands. In late April of 1952 head smut was again serious at Experiment in plantings seeded in the fall of 1951 with introduced seed. In these plantings 45 percent of the heads were infected. According to Dr. Julian H. Miller, head smut occurs commonly on rescue grass in the vicinity of Watkinsville, Georgia.

Grains in infected heads were replaced by smut galls covered with grayish membranes. The membranes ruptured to expose black powdery masses of teliospores (chlamydospores, brand spores). The teliospores were spherical to oblong, minutely and densely verrucose, and yellowish-brown. They measured 9.1-12.2 x 7.6-10.6 μ (av. 25 = 10.6 x 9.5 μ).

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GEORGIA EXPERIMENT STATION, EXPERIMENT, GEORGIA

NOTES ON SMALL GRAIN DISEASES IN GEORGIA FOR 1951-1952

Julian H. Miller, Acton Brown, and J. R. Johnson

Wheat Diseases. Leaf rust (Puccinia rubigo-vera tritici) was unusually late in appearing. The first infection was found in Piedmont surveys on volunteer Chancellor variety March 20, and only traces were observed in planted fields even in early May. All varieties planted in this area, such as Sanford, Redhart, Atlas, and Chancellor, showed some rust late in May just before maturity. On the other hand, in the region just below Macon even the top leaf was heavily rusted by May 1 in some fields while in others there were only traces of uredinia. The loss then should be much less than usual, about 5 to 10 percent. This could be accounted for by the previous summer drought during which very little volunteer wheat survived, especially in the upper Coastal Plain region. This is the bottom of the wheat belt and is the usual source of inoculum for fields farther north.

Other diseases of less importance were powdery mildew (Erysiphe graminis), with about 75 percent of the leaves in most fields of Chancellor showing some infection by April 15 and with less on the other varieties. The heaviest infections were correlated with high soil nitrogen. Leaf spots (Septoria tritici and S. nodorum) were observed in all fields in early April and all varieties seemed equally susceptible. Stem rust (Puccinia graminis tritici) again appeared very late, about May 22, and was found only on scattered plants in most fields except in one late-planted field of Chancellor.

Mosaic (virus) was not found on any varieties and even fields of Atlas in Oconee and Madison Counties showed no symptoms.

Oat Diseases. Beginning in early December leaf blotch (Helminthosporium avenae) was observed in all fields surveyed and was especially severe where oats followed oats. No varietal differences were noted. Leaves, especially lower leaves, were red during this winter period and infections were very evident up until the latter part of April. This has always been a seedling disease and apparently disappears during the boot stage.

The other blight (Helminthosporium victoriae) has all but disappeared since the epiphytotic of 1946-47, when it was found in most fields of oats with Victoria genes. This year, on the contrary, we found the disease only in one old field of oats that had volunteered since 1947. The yield in this Victorgrain field was reduced from 50 bushels per acre in 1946 to 8 in 1947. This year, 1952, other fields of oats on this farm showed no H. victoriae infections. All other fields in the Piedmont surveyed showed none, even though some of them had been in Victorgrain or Fulgrain for four consecutive years. The former is still the most widely planted variety in the Piedmont. Recently Atlantic and Arlington and some rust-proof types have been planted, but no lodging typical of H. victoriae was found in any field.

Seedling crown rot (Helminthosporium sativum) was found in one pasture in Oconee County where oats had been planted in a mixture for several years. At least half of the plants died in this field.

Crown rust (Puccinia coronata) appeared very late in the Piedmont and most fields matured with no rust. Only a few fields of late or spring-planted oats were affected. In extreme south Georgia some heavily rusted fields were observed on May 1.

Mosaic (virus) was found in one Victorgrain field with about 1 percent affected plants. This is our first observation in a farm field.

Barley Diseases. The most important disease was loose smut (Ustilago nuda), which appeared in 10 to 15 percent of the plants in all fields inspected. Powdery mildew (Erysiphe graminis) also was observed in all fields and by May 1 most leaves showed some infection. Barley is a very minor crop in Georgia.

Scald (Rhynchosporium secalis) and stripe (Helminthosporium gramineum) were found only in the Agronomy plots and not in farm fields. No net blotch (H. teres) was observed this year.

A physiologic black spot of leaves was common on Colonial in the Agronomy nursery. This was also very prevalent last year on the same variety.

COLLEGE OF AGRICULTURE, UNIVERSITY OF GEORGIA, ATHENS, GEORGIA

TESTS FOR ELM PHLOEM NECROSIS

Ralph W. Ames

Any test that will make possible quick and certain detection of phloem necrosis in an elm tree before the tree reaches the stage when symptoms are evident will be valuable in studying the disease. Also, such a test might be used in the future as a guide in applying treatments or carrying out protection, sanitation, or eradication programs.

The following tests, which have proved effective for other plant virus diseases, were tried: Lindner's (1, 3) rapid chemical test, Lindner, Kirkpatrick and Weeks' (2) leaf staining technique, the ferric chloride and ceric nitrate tests for phenols and enols (5), Simonds and Bodine's (6) test for peach mosaic, and color reactions based on differences in pH. Tests were run on leaf, inner bark and inner trunk bark tissue of diseased and healthy trees, using both frozen and freshly collected material, on fresh leaf material of one greenhouse-grown tree which has apparently recovered from the disease, and on fresh twig tissue of diseased, healthy, and recovered trees. Diseased leaves were collected from large trees between October 6 and 11, 1950, and frozen. Healthy leaves were collected from young nursery stock and elm sprouts exhibiting vigorous growth on October 9, 1950, and frozen. Both diseased and healthy leaves were green or green-yellow when collected. Inner bark from diseased and healthy trees was collected November 1, 1950, and frozen. Diseased bark was taken from large dying trees and showed the butterscotch color typical of the disease. Healthy bark was taken from young nursery-grown trees. Fresh material was collected in the spring of 1952 after the trees were in leaf. All experiments were performed in the spring of 1952.

LINDNER'S RAPID CHEMICAL TEST

Lindner's rapid chemical test, based on the oxidation of polyphenols, gives a red color when leaf sections of certain virus-infected trees are immersed in the test solution. While this technique has been employed only in the detection of virus diseases of stone fruits, the absence of a quick diagnostic method for the detection of elm phloem necrosis suggested its application to this disease. Sample discs 6 mm. in diameter were taken with a paper punch along the midrib halfway out from the base of the leaf or in the lamella midway between midrib and leaf edge and midway between base and tip of the leaf. With fresh leaf material, leaves of the same stage of growth were used. As all frozen leaves were collected in the autumn, they probably were of about the same age. With samples of bark and twig, approximately 0.05 gr. (wet basis) of ground tissue was used. Results of the tests were determined by observation. Five color categories based on change from the light blue of the test solution were chosen: pale green, brown green, green brown, brown red, and red. Results are given in Table 1.

There was no difference in reaction between bark samples from healthy and diseased trees or between twig samples from healthy, diseased, and recovered trees. Results with frozen leaf tissue were quite erratic, those with fresh leaves were rather consistent. The color was more pronounced in the leaf tests when the discs contained midrib rather than lamella alone. In general, with the frozen material, larger leaves from diseased trees gave a deeper red than smaller leaves from the same trees. More consistent readings might have been made on a colorimeter, but we were primarily interested in finding a test that would be fast, simple, and easily done in the field.

LINDNER, KIRKPATRICK AND WEEKS' LEAF STAINING TECHNIQUE

The staining technique of Lindner, Kirkpatrick and Weeks, based upon the killing, fixing, and subsequent staining of accumulated phenolic compounds in virus-affected tissues, gives a blue color when polyphenols are present in the tissues tested. This technique has proved effective in detecting virus-infected plants in those species having a polyphenol system similar to that found in deciduous fruit trees. As it is not known whether elms have such a polyphenol system, there is a possibility that this test may detect elm phloem necrosis.

Fresh leaves from a healthy tree, a diseased tree, and a tree that has recovered from phloem necrosis were used. Diseased leaves turned dark blue after being heated in the NaOH solution for approximately two minutes. After being removed from the NaOH and placed in the open air, they turned dull red throughout. Healthy leaves and those from the recovered tree developed no color, even after being removed from the NaOH and placed in the open air. All leaves, when removed from the NaOH solution and placed in lactic acid, became quite transparent, but diseased leaves,

Table 1. Color reactions of tissues of healthy elms and elms affected with phloem necrosis when subjected to Lindner's rapid chemical test.

Tissue tested	Treatment of tissue	Number of tests showing particular color reactions					Number of tests made	Number of trees tested
		pale green	brown green	green brown	brown red	red		
Healthy leaf								
lamella	frozen	0	18	20	5	0	43	1
lamella	fresh	17	33	0	0	0	50	23
lamella[a]	fresh	9	0	0	0	0	9	4
midrib[a]	fresh	6	0	3	0	0	9	4
Diseased leaf								
lamella	frozen	0	24	4	26	12	66	1
lamella	fresh	15[b]	0	0	27	23	65	9
lamella[a]	fresh	2	1	2	3	4	12	4
midrib[a]	fresh	0	2	1	5	4	12	4
Recovered leaf								
lamella	fresh	10	5	0	0	0	15	1
Trunk bark								
healthy	frozen	0	0	0	0	14	14	1
diseased	frozen	0	0	0	0	14	14	1
Root bark								
healthy	frozen	0	0	0	0	14	14	1
diseased	frozen	0	0	0	0	13	13	1
diseased	fresh	0	0	0	0	4	4	1
Twigs								
healthy	fresh	0	0	0	0	15	15	15
diseased	fresh	0	0	0	0	15	15	2
recovered	fresh	0	0	0	0	15	15	1

[a] Samples from the lamella and midrib were taken from the same leaves.
[b] All from the same tree.

when so treated, developed a dull red tinge not evident in healthy or recovered leaves.

These results suggest that this technique may be used to distinguish healthy elms from elms affected with phloem necrosis. Further study is needed to determine its usefulness and reliability in detecting infected trees before symptoms become visible.

FERRIC CHLORIDE AND CERIC NITRATE TESTS

The odor of oil of wintergreen emanates from the inner bark of buttress roots and lower portions of trunks of elm trees affected with phloem necrosis. Methyl salicylate is the chief constituent of oil of wintergreen. It possesses a phenol group. Hence, if the odor is due to oil of wintergreen, colorimetric tests for phenol might indicate the presence of the compound.

Aqueous and alcoholic extracts of diseased and healthy leaf, inner root bark, and inner trunk bark tissue, when treated with dilute $FeCl_3$ all failed to give the desired red color. Extracts of both diseased and healthy bark gave a blue color, indicating the presence of tannins (7). The fact that a darker blue was obtained with extracts from diseased trees may have been because these samples were from older trees that contained more tannin. Control tests with synthetic oil of wintergreen gave the expected red color. Although the production of color with $FeCl_3$ is typical of phenols and enols, many such compounds do not give color reactions. Hence, a negative test

must not be taken as significant without supporting evidence.

The ceric nitrate test, a delicate test in which fewer substances interfere than in the $FeCl_3$ test, failed to give any color differentiation with either water extracts or dioxane extracts of leaf or bark tissue of diseased and healthy trees.

SIMONDS AND BODINE'S PEACH MOSAIC TEST

Thin freehand sections about one-quarter inch in diameter were cut from stems and roots of healthy and diseased trees and from a tree which has recovered from phloem necrosis. These sections were then treated with phloroglucinol (in 100% methyl alcohol) and nitrophenolic acid, according to the directions of Simonds and Bodine. No differentiating reactions were found in sections so treated. All sections turned colors varying between violet carmine and blackish red-purple of Ridgeway (4). This technique apparently cannot be used to distinguish between healthy elms and elms affected by phloem necrosis.

pH COLOR INDICATOR TESTS

Aqueous and alcoholic extracts (2 1/2 gr. of tissue per 30 ml. of liquid) of frozen leaf, inner root bark, and inner trunk bark of diseased and healthy trees and aqueous and alcoholic extracts of fresh leaf tissue from diseased and healthy trees were tested with pH color indicators to determine differences in pH between diseased and healthy tissues. Indicators used were brom cresol green, methyl red, chlor phenol red, and brom thymol blue. Readings were taken immediately upon making the extract and at intervals of 1 1/2, 3, 24, and 48 hours afterwards. In no case was there any difference in color reaction between the extracts from the barks of diseased and healthy trees. There was a decided difference in color reaction between the extracts of diseased and healthy frozen leaves in three tests, two with chlor phenol red and one with brom thymol blue, but the difference was not consistent in the other tests. It was possible sometimes to distinguish diseased leaves from healthy leaves, when extracts from fresh leaves were treated with methyl red. However, the outlook for using pH color indicators to differentiate between diseased and healthy elms seems not very promising.

Concurrent with the above tests a Beckman pH meter was used to check the pH of the various samples. The range in pH and the most commonly occurring pH for the various tissues are given in Table 2.

Table 2. Beckman meter determinations of the pH of water extracts of diseased and healthy elm tissues.

Tissue	Treatment of tissue	pH range	Most commonly occurring pH
Diseased leaves	Fresh	4.4-6.4	4.7
Healthy leaves	Fresh	5.0-6.2	5.5
Diseased leaves	Frozen	5.2-6.7	6.6
Healthy leaves	Frozen	6.2-7.7	7.5
Diseased trunk bark	Frozen	5.5-6.2	6.1
Healthy trunk bark	Frozen	5.4-6.2	6.15
Diseased root bark	Frozen	5.0-6.0	5.9
Healthy root bark	Frozen	5.4-6.4	6.05
Check (dist. water)			6.1

Although, with the exception of the trunk bark extract, pH's of diseased extracts appear somewhat higher than those of healthy extracts, the overlap in range of pH is too large to permit use of this test as a quick and certain means for diagnosing phloem necrosis.

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SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

THE OCCURRENCE OF RHABDOCLINE NEEDLE CAST OF DOUGLAS FIR IN PENNSYLVANIA

W. J. Stambaugh and W. C. Bramble

Needle cast of Douglas fir (Pseudotsuga taxifolia (Lamarck) Britt.) is caused by Rhabdocline pseudotsugae Syd., a known parasite. The occurrence of Rhabdocline needle cast in Massachusetts, New York, and Rhode Island far beyond the natural range of its host has been reported by Weiss (3).

The appearance of R. pseudotsugae in Pennsylvania was first discovered by the authors in January 1952 while conducting studies of Christmas tree plantings in Susquehanna County. At that time the initial stage of infection appeared as yellowish spots and purple-brown bands on the current season's needles giving the trees a mottled appearance (Fig. 1). The disease was positively identified by Dr. J. S. Boyce of Yale University as needle cast caused by R. pseudotsugae.

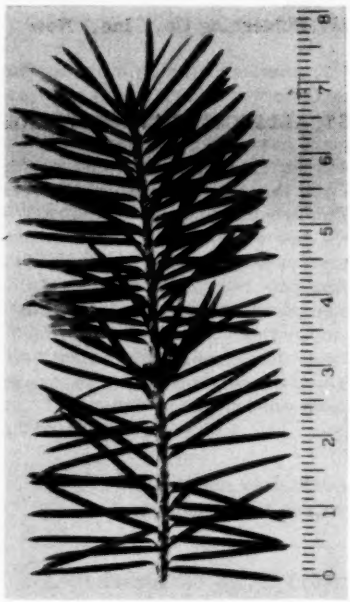

FIGURE 1. Mottled appearance of current season's needles of Douglas fir infected with R. pseudotsugae.

FIGURE 2. Infected needles bearing mature fructifications of R. pseudotsugae and extent of new growth.

Douglas fir is rapidly becoming an important Christmas tree species in Pennsylvania and extensive plantings are not uncommon, consequently further studies of the disease seemed advisable.

The affected area was again examined on June 2, 1952 at which time the new season's needles were almost fully matured. The characteristic elongated, cushion-like fructifications of R. pseudotsugae had then appeared in abundance on the lower surface of the needles where the discolored areas were formly in evidence (Fig. 2). The fructifications were positively identified by Dr. C. L. Fergus of The Pennsylvania State College, although the size of the asci varied somewhat from Sydow's original description.

From all indications it seems that mature spores are available for release when the current season's needles are just beginning their development. At the time of examination some of the fructifications had ruptured, exposing the orange-brown spore layer, and many of the ascospores had germinated. The ascospores of R. pseudotsugae are constricted in the middle and measure 21 µ in length and 9 µ in width. When mature they are two-celled but only one becomes thick-walled and dark, producing a single germ tube on germinating.

The infected trees varied from approximately 4 to 18 feet in height and are confined to a 50-

foot wide strip planting 0.7 acres in extent. From a total of 592 trees in the planting, 225 or 40 percent are infected. Heavy infections were noted on 68 percent of the infected trees or 25 percent of the total stand. From all indications the infection is at least two years old. A large field of approximately one-half million, uninfected young fir trees is situated adjacent to the infected planting.

The Cooley gall aphid (Adelges cooleyi Gill.) has been mentioned in the literature as being commonly associated with needle cast attack on Douglas fir. Its habit has suggested a possible vector relationship to this disease. The Cooley gall aphid was found on the current season's needles of both infected and healthy trees on the area under observation.

A spray schedule was initiated on June 2, 1952 to control the spread of R. pseudotsugae into the adjacent field of young Douglas fir. Boyce (1) suggests that spraying with Bordeaux mixture or lime-sulfur at the time of ascospore discharge should give adequate protection. One half of the plot was sprayed with Bordeaux mixture and the other half with lime-sulfur, with subsequent applications to be made at three-week intervals until growth ceases.

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DEPARTMENT OF FORESTRY, PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PENNSYLVANIA

FLOWERING DOGWOOD SPOT ANTHRACNOSE AND ITS CONTROL

Because of the increasing demand for information on this disease and its control, several articles bearing on the subject are assembled here.

SPOT ANTHRACNOSE OF FLOWERING DOGWOOD FOUND IN THE NASSAWANDA FOREST, MARYLAND, AND ISOLATION OF THE PATHOGEN

By Anna E. Jenkins

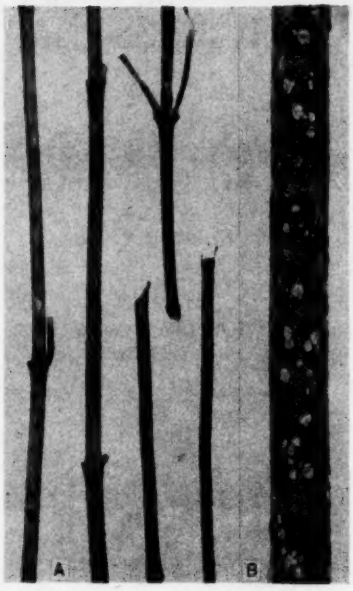

FIGURE 1. Stem cankers of flowering dogwood spot anthracnose from the Nassawanda Forest, Maryland, September 20, 1951. A, X 3/4; B, part of second stem from the left, X about 3. Photographs by W. A. Mead.

On September 20, 1951, R. A. Jehle collected stem cankers of spot anthracnose of flowering dogwood in the Nassawanda Forest, Worcester County, Maryland. The disease is prevalent in Montgomery County (2, 3) but heretofore has not been found in that forest. The cankers were on the current season's growth and doubtless were formed when the stems were still green. On September 21 the writer made tissue cultures from the diseased stems. The plantings were placed on malt agar test tube slants and the cultures held in a refrigerator. On January 10, 1952, the writer observed that small compact thalli typical of Elsinoë were protruding from cankered parts of a few of the plantings and were spreading to the agar surface. This represents the first isolation of the spot anthracnose pathogen, E. corni (4). It also proves the identity of the prominent small cankers abundant on the stems from the Nassawanda Forest as spot anthracnose. On May 23, 1952, the writer made cultures on malt agar test tube slants for comparison at 5°, 10°, 15°, 20°, 25°, 30°, and 35° C. Gross cultural growth is readily apparent at all these temperatures except 5° and 35° C; the best growth is at 20 and 25° C. A culture has been deposited in the American Type Culture Collection as Number 11189 (1).

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4. Jenkins, A. E., and A. A. Bitancourt. 1948. Diagnosis of the Elsinoë on flowering dogwood. Jour. Wash. Acad. Sci. 38: 362-365.

DIVISION OF FOREST PATHOLOGY, BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING

ELSINOË CORNI JENKINS & BITANC., ON FLOWERING DOGWOOD IN GAINESVILLE, FLORIDA

By George F. Weber

During the later part of February, 1952, along the streets in Gainesville, Florida the buds of dogwood trees developed sufficiently to show the white color and attention was attracted to many of them because of their stunted and malformed condition. Closer examination showed many of the bracts (petals) to be characteristically marked with circular to elongate (lengthways of the bract)

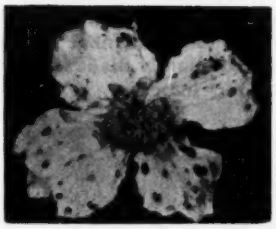
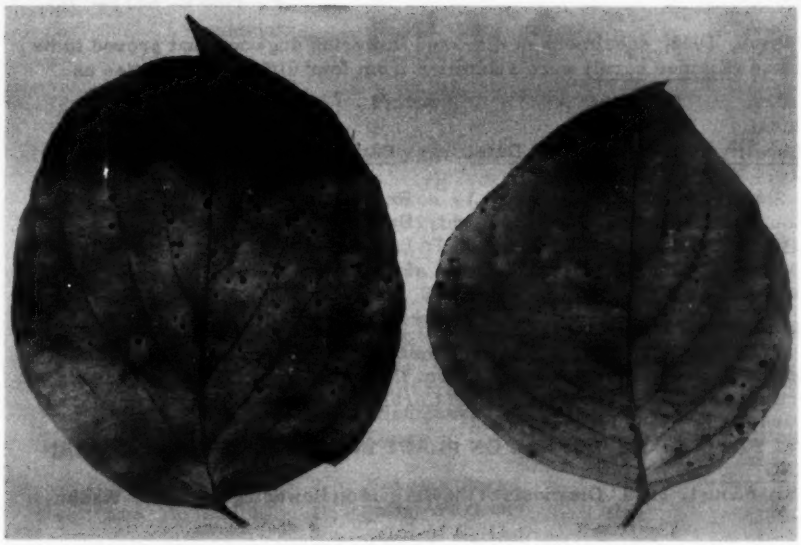


FIGURE 1. (left) Spot anthracnose on a "bloom" of flowering dogwood, Gainesville, Florida, March 2, 1952. X 3/4 Photograph by R. L. Taylor.

FIGURE 2. Spot anthracnose on leaves of flowering dogwood, Gainesville, Florida, March 10, 1952. X 1 Photograph by W. J. Mead.



reddish purple spots up to a millimeter in diameter and frequently surrounded by an irregularly less densely colored area with gradual blending or fading of the color to white (Fig. 1). There were from several to as many as 50 spots on a single one of the four bracts. Often one or more of the bracts was so badly stunted as to be barely recognizable. In most instances shedding actually took place on these trees before uninfected trees were at their height of bloom.

Further examination as soon as the foliage began to appear on these trees showed numerous small, circular dark purple spots, usually less than a millimeter in diameter. The spots were evident on opposite sides of the leaves but were usually slightly lighter colored on the under side. Transmitted light showed up definite pale halos of variable size, usually more extensive on the younger leaves (Fig. 2).

Cultures were made from the leaves by excising areas containing the lesion, washing in sterile water thoroughly, washing in 1:2000 bichloride of mercury solution for 5 minutes, again rinsing in sterile water, and planting on the surface of aseptically hard potato agar poured plates after being cut into halves. After five or six days characteristic fungus cultures developed from almost every planting with practically no contamination.

Further observations showed that some stem infections were developing but they were relatively few. The infection during March was very general, having been observed on widely scattered trees of the hundreds growing in Gainesville. No observations were made on trees in their native habitat in the woods in this county.

COLLEGE OF AGRICULTURE, UNIVERSITY OF FLORIDA, GAINESVILLE

SPOT ANTHRACNOSE (ELSINOË CORNI) ON CORNUS FLORIDA IN GEORGIA IN 1952

By Julian H. Miller

The first observations were made during the last week in March when the flower bracts were full open. In Athens the same trees that were severely affected last year again showed the same

degree of infection, and there was very little increase in numbers of infected trees. In Atlanta, on the other hand, the disease was more noticeable than in any previous year, especially in the Druid Hill's section, and the Office of the State Entomologist had a greatly increased number of telephone inquiries. There is one obvious fact, that is, one tree can be so completely diseased that its ornamental value is destroyed and others nearby often will not show any infection. The disease apparently spreads very slowly between trees on a street.

UNIVERSITY OF GEORGIA

RECORDS OF FLOWERING DOGWOOD SPOT ANTHRACNOSE IN NORTH AND SOUTH CAROLINA, 1952

By John S. Boyce, Jr.

During the spring season, 1952, specimens of diseased flowering dogwood that proved to be affected by spot anthracnose (Elsinoë corni) were submitted from four different localities as follows:

Locality	Date	Parts Affected
Greenville, South Carolina	April 15	Bracts and stems
Clemson, South Carolina	April 26	Bracts
Linville Falls, North Carolina	May 18	Bracts
Asheville, North Carolina	May 28	Leaves and stems

Specimens were also identified from Floyd, Virginia in 1950, and from Pine Bluff, North Carolina and Columbia, South Carolina, in 1951. More recently, G. M. Armstrong sent Dr. Jenkins specimens of spot anthracnose-infected leaves from flowering dogwood on the grounds of the Agricultural Experiment Station at Clemson, South Carolina. The earliest known record of the disease in South Carolina is in Georgetown, 1943[1].

DIVISION OF FOREST PATHOLOGY, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

[1]Jenkins, A. E. and A. A. Bitancourt. 1948. Diagnosis of the Elsinoë on flowering dogwood. Wash. Acad. Sci. Jour. 38: 362-365.

KNOWN DISTRIBUTION OF FLOWERING DOGWOOD SPOT ANTHRACNOSE IN MARYLAND, MAY 1952

By R. A. Jehle and Anna E. Jenkins

In May 1952 roadside survey for flowering dogwood spot anthracnose (Elsinoë corni) extended the known distribution in Maryland to include three new counties as well as several new localities in Montgomery County (Table 1). The three new counties are Carroll, Frederick, and Howard. All but two of the new localities (Glenmont and Takoma Park) in Montgomery County are north of Rockville, which was until this year the northernmost record of the disease in Western Shore

FIGURE 1. Map of Maryland showing counties (shaded) in which spot anthracnose has been found.

Table 1. Records of spot anthracnose of flowering dogwood in Maryland, May 1952.

County	Location	Date	Specimens collected by
Carroll	Mt. Airy	May 2	Jehle
	Taylorsville, vic.	May 2	Jehle
Frederick	Rt. 26, 1 mi. from Carroll Co. line	May 2	Jehle
Howard	Fulton	May 7	A. A. Bitancourt, Jehle and Jenkins
	Scaggsville	May 7	"
Montgomery	Ashton	May 7	"
	Clarksburg, vic., Rt. 27, 1/2 mi. from Jct. with Rt. 240	May 2	Jehle
	Clarksburg, vic., Jct. Rt. 240 and Deer Park Road	May 2	"
	Gaithersburg	May 2	"
	Glenmont	May 2	"
	Olney	May 7	Bitancourt, Jehle and Jenkins
	Takoma Park, Sligo Parkway, vic. of D. C.	May 1	Jehle

(Chesapeake Bay), Maryland. Slight to abundant bract spotting was present on most of the trees examined. The abundance of infection was doubtless enhanced by the rainy or humid weather at the time the bracts were expanding.

In a nursery near Gaithersburg the "bloom" of cultivated pink dogwood was severely affected. A moderate attack of pink "blooms" on the Eastern Shore was reported in 1951 (4).

Figure 1 shows the distribution of spot anthracnose of flowering dogwood in Maryland, by counties, based on previous reports (1, 2, 3, 5, 6, 7, 8) and the additional counties reported here.

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1. Jehle, R. A. and A. E. Jenkins. 1949. Roadside survey for spot anthracnose of flowering dogwood in Maryland, Virginia, Delaware and West Virginia. Plant Dis. Reptr. 33: 198-201. Illus. (map).
2. _____ and _____. 1950, Supplementary survey for spot anthracnose of flowering dogwood in Maryland and Virginia. Plant Dis. Reptr. 34: 225-227. Illus.
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DEPARTMENT OF PLANT PATHOLOGY, UNIVERSITY OF MARYLAND AND DIVISION OF FOREST PATHOLOGY, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING

PRELIMINARY INFORMATION ON THE USE OF FUNGICIDES FOR THE CONTROL OF SPOT ANTHRACNOSE OF FLOWERING DOGWOOD[1]

R. S. Cox and J. W. Heuberger

A leaf and "flower" spot disease was found in a nursery planting of flowering dogwood (Cornus florida), located near Lincoln, Delaware, in 1951. Early symptoms on bracts and leaves conformed fairly closely to those described for spot anthracnose (Elsinoë corni). Later, a question arose as to the identity of the disease on the leaves. A sample of diseased leaves, collected on August 14, was sent to Dr. R. A. Jehle, University of Maryland, College Park, Md., who identified the disease as Septoria leaf spot (S. cornicola). He stated, however, that Septoria frequently followed spot anthracnose infections.

In a preliminary fungicide test in 1951, Puratized Agricultural Spray showed remarkable eradicative properties against the leafspot organism (presumably Septoria). In view of this, a more detailed fungicide test was planned for 1952.

At this writing, the fungicide work is in its early stages but some interesting observations have been made. These are being presented at this time at the request of Dr. Anna E. Jenkins, Plant Industry Station, Beltsville, Maryland, for inclusion in the present series of notes on spot anthracnose.

Early bract and leaf symptoms found on May 5, 1952, again appeared to be typical of spot anthracnose. Pressed samples of this infected material sent to Drs. R. A. Jehle and Anna E. Jenkins were identified by them as spot anthracnose. In addition to bract and leaf spotting, cankers were present on stem growth of last year, as they noted. Septoria leafspot has not been observed in 1952, as yet.

In the fungicide test, a randomized block design is being employed. Each replicate of each treatment consists of 10 to 12 trees. Results of disease readings on bracts and leaves are shown in Table 1.

Table 1. Effect of various fungicides on control of spot anthracnose disease, Lincoln, Delaware, 1952.[a]

Materials	Concentration (lbs. - gals.)	Indices[b]		
		Bract infection[c]	Leaf infection[d]	Leaf injury[d]
Check	---	5.5	4.9	---
Orthocide 406	2-100	1.9	0.5	0.0
Puratized Agricultural Spray	1 pt.-100	0.8	1.1	2.3
Manzate	1 1/2-100	2.5	0.6	0.4
Parzate	1 1/2-100	3.2	2.0	0.0
Bordeaux Mixture	4-4-100	1.3	1.8	1.4

[a] To date, May 27, two fungicide applications have been made: April 29 (delayed dormant) and May 14 ("Petal" fall). More applications will be made.
[b] Based on the scale 0-11, with 11 equalling 100 percent. Average of two independent readings per replicate.
[c] May 5, 1952
[d] May 21, 1952

The disease is developing rapidly. On May 5, only a trace of leaf infection was observed. By May 27, leaf infection was general on all the untreated trees.

It is interesting to note that only one application (delayed dormant) appreciably reduced bract infection as compared with infection of the untreated trees (Table 1). Also, all of the materials, so far, show good control of leaf spot. Parzate appears to be least effective. A higher concentration of this material, possibly 2-100, might be more effective.

Leaf injury caused by Puratized Agricultural Spray is considered to be of objectionable proportions[2]. Leaf injury caused by Bordeaux mixture is less severe. The slight injury caused by Manzate is not considered as being serious.

Definite conclusions cannot be drawn at this time, but it appears that control of spot anthracnose may be possible with an appropriate fungicide spray program.

DEPARTMENT OF PLANT PATHOLOGY, UNIVERSITY OF DELAWARE, NEWARK, DELAWARE

[1] Contribution No. 49 of the Department of Plant Pathology. Published with the approval of the Director of the Delaware Agricultural Experiment Station.

[2] This injury was not as pronounced in 1951. It is more noticeable this year on trees of low vigor.

A NEW HOST FOR SEPTOGLOEUM GILLII

Lake S. Gill

Septogloeum gillii D. E. Ell.[1] is known to be pathogenic on a number of species of Arceuthobium but no mention of its occurrence on A. americanum Nutt., the dwarfmistletoe attacking shore pine, lodgepole pine, and jack pine (Pinus contorta Dougl., P. contorta var. latifolia Engelm., and P. banksiana Lamb.), could be found in the literature.

In October 1948, A. americanum on lodgepole pine was observed to have suffered heavy mortality at several locations in the Lewis and Clark National Forest in Montana. Most of the living dwarfmistletoe shoots present were in a diseased condition, suggesting the anthracnose caused by Septogloeum gillii. A collection was made in the vicinity of Adams Ranch on Adams Creek on October 12, 1948. Recently a portion of this collection was sent to Dr. Ellis who has confirmed the presence of Septogloeum gillii on the material.

The spring and summer of 1948 were exceedingly wet, a condition that may account for the development of the fungus to epidemic proportions. Further observations in the mistletoe-infected lodgepole pine stands of the Lewis and Clark National Forest are planned for the summer of 1952.

DIVISION OF FOREST PATHOLOGY, BUREAU OF PLANT INDUSTRY, SOILS AND AGRICULTURAL ENGINEERING, ALBUQUERQUE, NEW MEXICO

[1]Ellis, Don E. 1946. Anthracnose of dwarf mistletoe caused by a new species of Septogloeum. Jour. Elisha Mitchell Scientific Society 62: 25-50.

BRIEF NOTES ON PLANT DISEASES

GLOEOSPORIUM ULMICOLUM REPORTED ON FRUIT OF ROCK ELM AND VARIEGATED ENGLISH ELM

By Ralph W. Ames

Black pustules of fruiting bodies of a fungus have been observed on the fruit of rock elm (Ulmus thomasi Sarg.) and variegated English elm (U. procera argenteo-variegata (West.) Rehd.) for several seasons in the vicinity of Champaign-Urbana, Illinois. Collections were made in 1945 and 1951. The fungus was identified as Gloeosporium ulmicolum Miles. Although quite common on elm leaves, this fungus apparently has not been reported on elm seed heretofore.

Infection occurs most commonly on the basal part of the fruit but may appear any place. The fungus is usually found in the vicinity of the seed, but may occur in small localized spots on the wings. The acervuli are numerous in any given spot and commonly are confluent. The spot is raised and gives the fruit a crumpled appearance. There is considerable distortion when a large portion of the fruit is involved.

SECTION OF APPLIED BOTANY AND PLANT PATHOLOGY, ILLINOIS STATE NATURAL HISTORY SURVEY, URBANA, ILLINOIS

OBSERVATIONS ON OCCURRENCE OF AZALEA PETAL BLIGHT IN MARYLAND

By W. F. Jeffers

Azalea petal blight (Ovulinia azaleae) was first recorded in Maryland in 1946 in a private planting near Washington, D. C. Plant pathologists of the University of Maryland surveyed azalea plantings in that vicinity and during successive years found the disease in a few other plantings. Attempts were made to eradicate the disease by spraying, but this was not successful.

It was feared that petal blight would soon become established and cause serious damage to the many azalea plantings in the Maryland area surrounding Washington, D. C. So far this has not been the case and little damage has been observed. It is hoped that this is evidence that petal blight is not going to become a serious problem in this area. The relatively cold winter temperatures of this section may be responsible for what appears to be slow development of this disease.

In this area petal blight has not seriously affected such early azalea varieties as Coral Bell, Pink Pearl, Hinodigiri, and Snow. However, in a few plantings it has for the past few years caused fairly severe damage to some of the late, large-flowered types. Anchorite, Caprice, Gaiety, Glamour, Greeting, Joya, Lavender Queen, Lilacina, Mai-Hime, and Maxwelli Red were all observed to be highly susceptible. Likewise a group of Kaempferi seedlings all were susceptible.

UNIVERSITY OF MARYLAND, COLLEGE PARK

MAINTAINING VIRULENT CULTURES OF ERWINIA AMYLOVORA AND SUGGESTION OF OVERWINTER SURVIVAL IN MUMMIED FRUIT

By H. W. Anderson

In connection with an experiment to determine the most convenient method of maintaining overwinter a virulent culture of Erwinia amylovora, an interesting observation was made on the ability of this organism to survive in mummied pear fruit. Green Kieffer pears were inoculated by needle puncture on October 20, 1951. These were retained in the laboratory until an evident invasion of the tissue had occurred. On October 29, they were placed in a refrigerator which was maintained at about 5°C. No difficulty was experienced in obtaining cultures from these pears throughout the winter and inoculations made on pear and quince shoots in the greenhouse during February and March showed that virulence had been maintained. All but one of the pears were discarded. When this one was examined in May, it had dried to a withered, gummy mummy. A fungus had invaded one side of the pear but had made little growth.

On May 22, this mummy was cut into small pieces, soaked in water and ground in a mortar. The resulting mass was strained through cheesecloth to secure a liquid inoculum. A portion of the juice was boiled. Inoculations of young pear and quince shoots were made from the strained liquid. Six shoots inoculated with the untreated juice showed typical blight symptoms within a

week, while shoots injected with the boiled juice remained free of blight.

This experiment indicates a convenient method of preserving virulent fire blight bacteria overwinter and suggests a possible source of inoculum for spring infections in the absence of hold-over cankers.

Hildebrand[1] in 1939 called attention to the protective action of the bacterial ooze when this was promptly dried and stored under dry conditions. In the experiment reported above the drying extended over several months and when the pear was finally cut up the flesh had about the consistency of a dried prune.

UNIVERSITY OF ILLINOIS, URBANA

[1]Hildebrand, E. M. 1939. Studies on fire blight ooze. Phytopath. 29: 142-156.

SOYBEAN DISEASES IN IOWA IN 1951

By J. M. Crall

Stem canker (Diaporthe phaseolorum var. batatatis) and brown stem rot (Cephalosporium gregatum) were the most important diseases on soybean in Iowa in 1951. Diseases of lesser importance were root and stem rot (Rhizoctonia solani), bacterial blight (Pseudomonas glycinea), bacterial pustule (Xanthomonas phaseoli var. sojense), wildfire (Pseudomonas tabaci), brown spot (Septoria glycines), downy mildew (Peronospora manshurica), frogeye (Cercospora daizu), Phyllosticta leaf spot (P. glycineum), mosaic (virus), pod and stem blight (Diaporthe phaseolorum var. sojae), and purple seed stain (Cercosporina kikuchii). Potash deficiency spots were found in a moderate number of fields in northern and eastern Iowa. A moderate amount of damage resulted from early frosts, especially in northern Iowa and in late-planted fields.

Stem canker was widespread, varying in prevalence in individual fields from a trace to 10 percent. Average infection was estimated at 1.5 percent. First infection was found on August 2 at Independence and considerable infection was found in a number of fields by August 10. Stem canker was not considered as serious in 1951 as in 1949 or 1950.

Brown stem rot was more widely distributed than in any previous year, being found in all parts of Iowa. First occurrence of the disease was noted on August 29 at Muscatine. Prevalence in individual fields varied from a trace to 100 percent.

Rhizoctonia root and stem rot was prevalent in northern Iowa and caused more severe local losses. However, it was less serious than in 1950. Other soybean diseases were of minor importance in 1951, although brown spot was present in almost every field, wildfire was severe in a few fields near Muscatine, and frogeye leaf spot was found in Iowa for the first time.

DIVISION OF FORAGE CROPS AND DISEASES, BUREAU OF PLANT INDUSTRY, SOILS, AND AGRICULTURAL ENGINEERING, AND IOWA AGRICULTURAL EXPERIMENT STATION, AMES, IOWA

A FUNGICIDAL CONTROL FOR POWDERY MILDEW, LEVEILLULA TAURICA (LÉV.) ARN., OF KENAF, HIBISCUS CANNABINUS L. IN SOUTH FLORIDA

By Warren N. Stoner

Kenaf, Hibiscus cannabinus L., has recently been grown commercially in South Florida as a possible source of soft fiber, and for seed increase. Several production problems were encountered during the 1951 growing season, and many diseases caused considerable loss. One, a powdery mildew, Leveillula taurica (Lév.) Arn., reported by Diehl[1], and Stoner[2], was found to some extent in all commercial fields. A late summer planting grown for seed at Indiantown, Florida by Mr. Bruce Leighton was heavily infected with this fungus in the fall at blossoming time. No record could be found suggesting a fungicide for control of this fungus. Moreover the plants had attained an average height of eight feet, making it impossible to use conventional ground spraying or dusting equipment.

Elemental sulfur applied as a dust is standard practice in the area to control various powdery mildews on other crops. Consequently an attempt was made to control L. taurica by applying a commercial grade dusting sulfur with an airplane to a 20-acre block that was heavily infected. Thirty pounds of the material per acre was used each time, and two applications were made ten days apart. These two applications were sufficient to bring the infection under control and the crop was finished without a recurrence of the disease.

Subsequent to the field control, the fungus was found on young experimental kenaf plants in the greenhouse. A single application of dusting sulfur made with a plunger type hand dust gun was sufficient to control the fungus completely in early cases of infection.

The foregoing field and greenhouse observations indicate that powdery mildew, L. taurica,

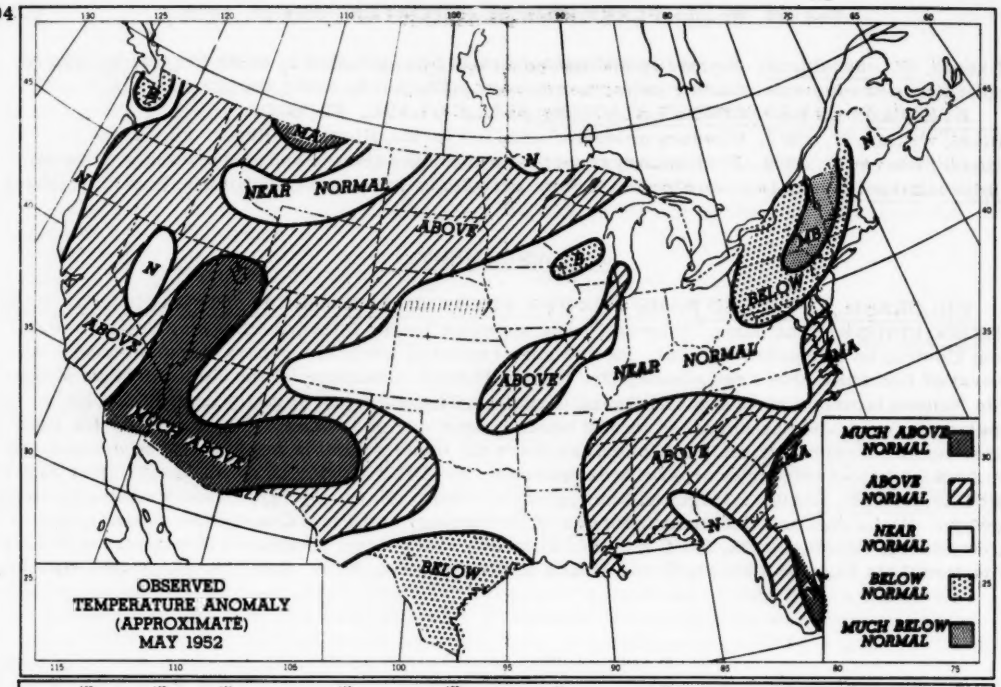
of kenaf, H. cannabinus, can easily and economically be controlled in south Florida by timely applications of elemental dusting sulfur in amounts sufficient to cover the plants.

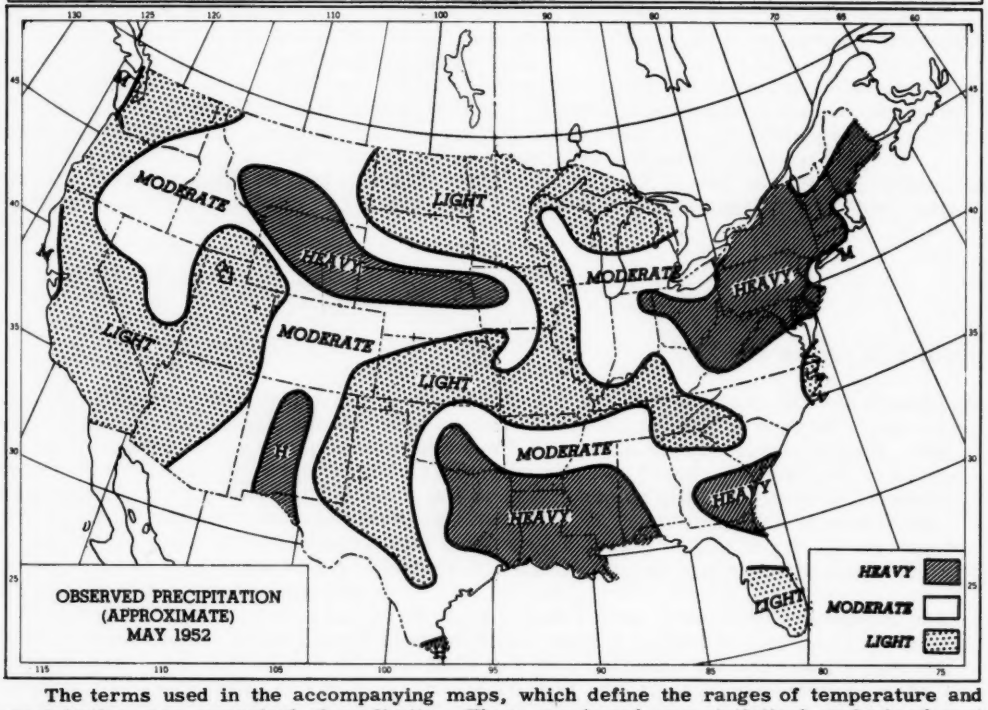
EVERGLADES EXPERIMENT STATION, BELLE GLADE, FLORIDA

[1]Diehl, William W. 1952. Powdery mildew of kenaf in Florida, Plant Dis. Reptr. 36: 52.
[2]Stoner, Warren N. 1952. Preliminary reports of some of the disease and pest problems of kenaf, Hibiscus cannabinus L. in south Florida. I Some pathological problems. Plant Dis. Reptr. 36: 122-123.

ANNOUNCEMENT

CHLORANIL, A COINED NAME FOR THE FUNGICIDAL CHEMICAL TETRACHLORO-PARA-BENZOQUINONE: The name "chloranil" was approved by the Interderartmental Committee on Pest Control on December 5, 1951, for the pure chemical tetrachloro-para-benzoquinone. Approval of this name was requested by Dr. Dwight Powell, Chairman of the Committee on Fungicide Nomenclature, University of Illinois, Urbana. The name had actually been in use for a number of years and has appeared in text books. Approval of the name "chloranil" by the Interdepartmental Committee on Pest Control renders the name available for free use in designating the pure chemical tetrachloro-para-benzoquinone. -- INTERDEPARTMENTAL COMMITTEE ON PEST CONTROL, Depts. of Agriculture, Interior, Army, Navy, Airforce, and Federal Security Agency. H. L. Haller, Chairman, Bureau of Entomology and Plant Quarantine, Department of Agriculture, Washington 25, D. C.; S. W. Simmons, Secretary, Technical Development Branch, Communicable Disease Center, U. S. Public Health Service, P. O. Box 769, Savannah, Georgia.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.